Towards an LEK-informed conceptual model of Greenshell mussel spat catching: Pelorus Sound and Wainui Bay, New Zealand

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New Zealand is the leading producer of mussels in Oceania with a total production of 94 thousand tonnes per year from 2010 to 2015 (Wijsman, Troost, Fang, & Roncarati, 2019). New Zealand is known for endemic mussel specie, Perna Canaliculus, also known as green-shelled mussels (green mussels). Traditionally, up to eighty percent of P. Canaliculus spat came from Ninety-mile Beach where vast quantities of spat wash up along with macroalgae. Mussels spats are also locally caught in "Wainui Bay, Aotea, Harbour, Kawhia harbour, Opotiki and Pelorus Sound" which provides up to 30 percent of the national spat requirement (Atalah & Forrest, 2019; Aquaculture NZ, 2020).

There was no literature on the local ecological knowledge (LEK) of local spat catching. Therefore, this dissertation examined the extent of LEK of the local spat catchers that can help planners understand the socio-ecological environment of spat catching. The Pelorus Sound and Wainui Bay were elected as the quintain, and the spat catchers within the areas were the cases respective to each area. The semi-structured interviews with interactive components were conducted with scientists, planners and spat catchers to fully conceptualise the regulatory, biophysical factors, technology involved and community interactions that characterise the spat catching LEK.

The result has shown that replacement coastal permit pathway and the rules within the regional council was relevant to both Wainui Bay and Pelorus Sound. The spat catcher can develop more effort to develop social licence to operate (SLO) if necessary. The biophysical factors identified in LEK sometimes aligned or were inconclusive with current scientific knowledge because the spat catchers were too reliant on spatfall monitoring system. The method of spat catching depended upon the geographical location and was divided into two methods; shallow and deep spat catching which utilised the knowledge of water column. There were variation in configuration and materials used for spat catching which reflected that the LEK was driven economic success, not by cultural or spiritual beliefs.

The findings from the interview and body of literature were included in conceptual input-output diagrams that outlined the LEK. The input-output model received feedbacks from the planners who were interviewed. The planners all stated that the model could be used as an educational tool for planners who are new to aquaculture and coastal planning. Therefore the primary benefits from this research are not perhaps the original questions about the values of LEK for planners but the value of the diagram in itself and the process that the author went through to develop the map that resulted in a practical and useful tool for planners especially planners who are not familiar with the aquaculture and coastal environment.

Keywords: Local Ecological Knowledge, LEK, Aquaculture, Mussel Spat, Green-shelled Mussel Spat, Perna Canaliculus spat, Resource Management Act 1991, Fisheries Act 1996, National Environmental Standard for Marine Farming, Collaborative Consensus Building, Planning

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Chapter 1
Introduction

New Zealand is the leading producer of mussels in Oceania with a total production of 94 thousand tonnes per year from 2010 to 2015 (Wijsman, Troost, Fang, & Roncarati, 2019). New Zealand is known for endemic mussel specie, Perna Canaliculus, also known as green-shelled mussels (green mussels). Traditionally, up to eighty percent of P. Canaliculus spat came from Ninety-mile Beach where vast quantities of spat wash up along with macroalgae. mussels spats are also locally caught in “Wainui Bay, Aotea, Harbour, Kawhia habour, Opotiki and Pelorus Sound” which provides up to 30 percent of the national spat requirement (Atalah & Forrest, 2019; Aquaculture NZ, 2020).

Green mussel spat catching in New Zealand uses the longline method. The Longline system refers to paired horizontal support ropes attached to a series of large polyethylene floats (Jenkins, 1979). Fibrous ropes that act as artificial settlement surfaces for spats are attached in certain configurations to the paired support ropes (Jeffs, Holland, Hooker, & Hayden, 1999). There is small body of scientific literature that has examined the green mussel spat however none of the literature has examined the knowledge of local marine farmers who do spat catching.

Local Ecological Knowledge (LEK) is defined as non-traditional local knowledge which differs from Indigenous Knowledge. LEK assumes that knowledge is developed as a way to survive (Berkes, 2018). Accordingly, spat catching LEK of marine farmers includes the knowledge to survive the regulatory, economical and societal and ecological environment in New Zealand (Ruddle & Davis, 2013). No literature have examined the potential of spat catching LEK in the context of coastal planning in New Zealand.

The research reported here explores the extent of spat catching LEK that can facilitate the planners to understand the socio-ecological environment of Perna Canaliculus (green mussel) spat catching. The following research question was developed for this dissertation;

To what extent does LEK facilitate planners to understand the dynamics of the socio-ecological environment of P.Canaliculus spat catching?

To address this question, it was intended to achieve the following objectives:

- Identify the legislation, policy, rules, resource consents and other regulatory mechanisms that had significant effects on spat catching operation and the way the spat catch catchers have adapted to regulatory environments.
- Identify the community interactions that may have changed the spat catching operation.
- Identify the various biophysical factors that are related to spat catching operation:
- Examine the changes in technology within the socioecological environment.

The focus of this research is restricted to spat catching LEK to manage the scope of the research. The findings of this study can be applied to develop consensus building and providing an overview of mussel spat catching operation. Furthermore, the process of developing the conceptual LEK model will be applicable to coastal, marine and land based LEK model development.

This dissertation is structured as follow. Following this introduction, the research context is described in Chapter 2 which leads to a research context to the mussel spat catching, LEK and extending LEK definition to include the socio-ecological environment. Furthermore, linking LEK with collaborative consensus building and the social licence to operate is discussed as linkage with LEK. Chapter 3 describes the methods used to gather data and the results presented in Chapter 4, 5 and 6. Chapter 4 presents the coastal permit pathway from resource management legislation in New Zealand (specifically, Resource Management Act 1991 and Fisheries Act 1996), replacement coastal permit pathway for Pelorus Sound (namely rules from Marlborough Sound District Council) and Wainui Bay (namely, Tasman District Council), relevant policies from New Zealand coastal policy statement and the national environmental standard for marine aquaculture 2020. Chapter 5 provides the findings from the spat catching operations Chapter 6 provides the findings on community interaction and the feedback for the conceptual LEK model developed. Chapter 7 presents the discussion where the key results from Chapter 5 and 6 are discussed with the literatures from Chapter 2. Finally, Chapter 8 provides a summary of the research and reflection on LEK and possible subsequent studies.

The following dissertation referred *Perna Canaliculus* as green mussel and *Mytilus Galloprovincialis* referred to as the blue mussel. Furthermore, ‘the author’ refers to the writer of this dissertation who has conducted this research.

Chapter 2

Research Context

This chapter provides a context for this research by providing a review of relevant literature. It first gives context to spat catching technology used in New Zealand. Subsequently, scientific literature on the green mussel spat settlement patterns and scientific findings from spat catching operations are given. This chapter discusses the definition of Local Ecological Knowledge (LEK) in the context of green mussel spat catching. In addition, the chapter reviews spat catching LEK with the social licence to operate (SLO) and collaborative consensus building.

2.1 Context to spat catching technology used in New Zealand

Longline system refers to the paired horizontal support ropes that are connected by large polyethylene floats. The fibrous spat catching ropes are tied to the support rope to reach a certain depth of water. The longline system was first developed in Japan and it was brought to New Zealand and initiated by the Fishing Industry Board in 1974 (Jenkins, 1979). The first recorded spat catching longline was in Crail Bay 1975 (Dawber, 2004). The longline system had several advantages over constructing a raft structure because it had a simple design and low capital cost. The longline system had minimal impact from the current drags and surface debris accumulation. Additionally, it was less intrusive to the aesthetics of the environment and boat traffics compared to rafts (Jenkins, 1979).

2.2 Current scientific understanding of P.Canaliculus

Mussel spat is the settled mussel larvae that follow primary and secondary settlement pattern. Primary settlement refers to the metamorphosis of mussel larvae from freely moving veliger larvae into settled larvae (spat) on a finely branched medium. Green mussel spat that are smaller than 0.5 mm were observed to settle onto finely branched macroalgae such as *Champia laingii, Corallina officinalis, Laurencia thyrisfera* (Buchanan & Babcock, 1997). Fast water flow (10 ms^{-1}) induced primary mussel settlement and the spat better in faster water flow (Alfaro, 2005). A cluster of specific bacteria on a surface (known as bacterial film or biofilm) also caused primary settlement. The biofilm from the guts of the mussels induced green mussel primary settlement caused by a specific protein in the bacterial biofilm (Ganesan, Alfaro, Brooks, & Higgins, 2010).

If the conditions are unfavourable, green mussel primary settlers can migrate to different places which are known as the secondary settlement. Spats in secondary settlements are bigger and tend to attach to coarse textured macroalgae (Buchanan and Babcock, 1997). Secondary settlers that were exposed to high turbulence by air bubbles and fast water flow improved survivability and retention onto a surface better (Alfaro, 2005, 2006).

Both primary and secondary settlement can migrate to different places by detaching byssus thread. Byssus threads are produced by the green mussel spats and enable the mussel spat to adhere to a surface. Both primary and secondary settlers can produce long buoyant mucus threads that become entangled on themselves by water current to create a parachute like structure. The mucus threads slow the mussel spat descent up to 70 percent which enables the spat to drift long distances by water current (Buchanan and Babcock, 1997).

It is currently not clear whether the mussel spats used in the literature are comparable to the spats caught on the spat catching rope. The body of scientific literature all have used Kaitaia mussel spats (green mussels from Ninety mile beach) or spats from a hatchery in their studies. There are no studies that have explored the differences in Kaitaia mussels and locally caught spats in terms of phenotype and genotype. It is not clear whether hatchery mussel spats are fit to survive in the sea because there are no definite reports or academic literature specific to hatchery mussel spats. Therefore, there is a gap in the literature on whether local wild-caught spats have the same behavioural and physical characteristics as Kaitaia or hatchery spats.

2.3 Current scientific understanding in relation to spat catching operation

Spats are caught on the rope, it is left on the longline for four to eight weeks until it matures to a size less than 1 mm in size (Jenkins, 1979). High spat losses occur once it is transferred to another site (South, Floerl, & Jeffs, 2019). Up to 72.9 percent of mussel spat are lost within 19 days and slower spat losses occur until an additional 12 percent of mussel spats are lost over subsequent 70 days (South, Floerl, & Jeffs, 2020).

Secondary settlement behaviours are likely to be triggered whenever the conditions on the rope and its surrounding become unfavourable (Jeffs, Holland, Hooker, & Hayden, 1999). Similar to the findings of Alfaro (2006), turbulence, faster water flow influence the growth, survivability and retention of green mussel spat onto the rope (Sanjayasari & Jeffs, 2019).

Once the spats have grown to 10 to 20 mm, the green spat are mechanically stripped from the rope and are seeded onto a new spat catching rope on a lower density of spats per line (Jeffs et al 1999). Retention of green mussel spat on a new line is difficult. The highest spat losses on a seeded line occur within the first month (South, Floerl, & Jeffs, 2017). An experiment was conducted with seeded mussels that were exposed to fast water flow such as 40 cms^{-1} for 8 weeks. It grew significantly in size and retained the best compared to mussels exposed to 1 cms^{-1}, 3 cms^{-1} and 10 cms^{-1} (Hayden &

Woods, 2011). Desiccation of seeded lines potentially caused during the transportation, may also result in lower retention (Carton, Jeffs, Foote, Palmer, & Bilton, 2007).

Biofouling in mussel spat catching refers to the accumulation of various organisms onto a submerged spat catching ropes. Biofouling species included Colponneia Spp, red algae, Ascidina species, Undaria inntifida and Mytilus galloprovincialis (blue mussels). Interestingly, the blue mussel is the one of notable biofouling species for P.Canaliculus mussel industry. It is calculated that the annual regional revenue loss caused by M.galloprovincialis is equivalent to 10 percent (Atalah, Rabel, & Forrest, 2017).

2.4 Defining Local Ecological Knowledge (LEK) and applying to green mussel spat catching

Although there are various scientific literature on mussel spats, there are no academic literature that have examined the local ecological knowledge on aquaculture nor on mussel spat catching. Berkes (2018) have categorised ecological knowledge into three distinct categories; local ecological knowledge (LEK), traditional ecological knowledge (TEK) and indigenous ecological knowledge (IEK). There are controversies on the categorization because the definitions overlap over another and researchers use the three terminology interchangeably (Gadgil, Olsson, Berkes, & Folke, 2003; Mazzocchi, 2006). LEK is non-traditional local knowledge of the area. TEK are ecological knowledge with cultural components and adaptive processes that are inherited for many generations and IEK is a subset of TEK where indigenous knowledge is tied to unique culture and society. LEK and TEK is not clear because the notion of "traditional" is not defined properly. It raises the question of whether LEK can be converted into TEK after a specific amount of time or whether it requires the knowledge to be transferred to next generation (Davis & Ruddle, 2010). Some studies have shown that modern local ecological knowledge can emerge (Aswani, Lemahieu, & Sauer, 2018; Chalmers & Fabricius, 2007; Gilchrist, Mallory, & Merkel, 2005).

LEK are knowledge shaped by observation. Murry, Neis & Johnsen (2006) showed that controversial results can occur if the method does not differentiate the observations from the theories of fishermen. Theories of fishermen are attempts to explain the observations which may not be rigorously tested thus can be treated as hypotheses that researchers should test (Hill, Michael, Frazer, & Leslie, 2010). In New Zealand, spatfall forecasting is used to identify patterns of P.Canaliculus settlements in spat catching areas. The freely moving mussel larvae in the water are microscopic thus they may not be seen easily with the naked eyes. The spatfall forecasting utilises the mussels spats that have settled and grown into observable size on the rope. Spatfall forecasting is a weekly sampling of P.Canaliculus settlements on PVC I shaped frames with sampling ropes that are suspended from a small buoy on specific locations. The P.Canaliculus spats are counted using a microscope. This method is adapted from oyster industries and enabled to quantitatively understand the seasonal patterns of the spat catching site (Jenkins, 1979). Therefore the spat settlement monitoring data can be used to identify patterns of mussel larvae concentration in specific locations. Atalah & Forrest (2019) have assessed the spat settlement monitoring to develop a prediction model in Wainui Bay and Pelorus Sound. Therefore, the spat catchers may be utilising the predictive models and develop theories from it as well (Atalah & Forrest, 2019; Murray, Neis, & Johnsen, 2006).

Technology is a factor that shapes LEK. Murray, Neis & Johnsen (2006) have found that a particular fisherman's LEK changes with different equipment because different types of skills and observations are required to catch fish. In mussel spat catching context, one of the key equipment is the material and configuration of ropes on a longline system. Initially, coconut fibre ropes known as coir ropes were used but biodegraded too quickly in the water thus unsuitable to support the weight of spats once settled (Jenkins, 1979). Currently, the filamentous ropes are used to catch green mussel spat where the fibrous parts of the rope mimic the highly filamentous macroalgae to induce primary settlement (Alfaro & Jeffs, 2003).

The LEK in this research can be conceptualised as practical and specialised knowledge developed mainly by the observation, understanding of the local environment, understanding of the specie of interest, monitoring technology and the equipment to catch the specie of interest. The observations of the local environment and experiences of using equipment enable LEK holders to develop possible theories that can improve or change operations (Hill, Michael, Frazer, & Leslie, 2010). Most literature mostly focused on the behaviours of the species of interest and its interaction with the local environment and the equipment (Atalah & Forrest, 2019; Gadgil, Olsson, Berkes, & Folke, 2003; Mazzocchi, 2006; Murray, Neis, & Johnsen, 2006).

The concept of LEK can be more fully conceptualised by expanding "local ecological environment" to "socio-ecological environment". Regulations or social expectations can impact technology or practices. For example, in New Zealand, the explosives and poisons were previously used to daze or drive away from the predator such as snappers. These explosives and substances were banned because these practices were not accepted and induce bad images in the industry (Dawber, 2004). Therefore, the local community and the general public may need to understand and accept the spat catching operation. Otherwise, the spat catchers may face difficulty in carrying out their operations by disruptions by the public, or reduction in economical gain. Therefore the perception of the public and the local community could be an important aspect.

Social licence to operate is a useful concept because it generally refers to building trust and honesty during communication to maintain a positive relationship between the aquaculture business owners and local communities. The social licence to operate can impact aquaculture operation because the societal attitude can constantly change or evolve while legal licence may only address the minimum (Edwards & Trafford, 2016). Indeed, the relationship developed from SLO could influence the operation and thus adapting and testing different alternative solutions which contribute to LEK.

2.5 LEK and social licence to operate (SLO).

The depth of LEK is beyond environmental knowledge of a specific area. Society is a part of the ecosystem thus LEK should include analysis of the local level of society and associated power interactions. (Ruddle & Davis, 2013). Aquaculture sectors are likely to be susceptible to changes in local government regulatory procedures and national legislations (Cordón Lagares, García Ordaz, & del Hoyo, 2018). Therefore, mussel spat catching LEK should include regulatory and legislative landscape (Ruddle & Davis, 2013).

if LEK extends to the social domain, it needs to explore social licence to operate (SLO) because it generates social capital with the local community (Quigley & Baines, 2014). Currently, no literature have explored the relationship between LEK and SLO. SLO in New Zealand marine space have recently emerged but the definition is not explicit and implicitly too diverse in its meaning. It is problematic that the New Zealand aquaculture SLO has no theoretical context (Newton, Farrelly, & Sinner, 2020). Representatives from large aquaculture company and the local community identified that trust, transparency in communication and openness were as important to build a positive relationship which leads to SLO. Large aquaculture company utilised reciprocal initiatives to communicate and engage with locals which include beach-clean ups, responding to complaints, writing environmental reports and providing locals information on the aquaculture operations (Baines & Edwards, 2018). Quigley & Baines (2014) suggests that the formal consultation alone do not result in obtaining SLO because the feedback from local to the aquaculture company become limited.

Currently, the body of LEK literature lacks methodological consistency and clarity. Ruddie & Davies (2013) argues that poorly designed researches do not capture LEK fully. The selection of LEK experts is important because true experts can reveal comprehensive LEK based on the life time of experiences whereas local residents may have limited or LEK that is based on limited observations (Chalmers, & Fabricius, 2007). Some LEK researchers failed to explain the selection of 'local experts' (Bender, Floeter, & Hanazaki, 2013; Lima, Oliveira, de NÓBrega, & Lopes, 2017; Olsson & Folke, 2001). Much of the literature has only outlined that the researchers have selected 'local experts' but does not identify whether these experts actually were qualified. Olsson & Folke (2001), for instance, did not specify the number of peer recommendations that are needed to qualify someone as a 'local expert'. Accumulation of academic literature with poorly designed researches can impede LEK from being a truly interdisciplinary research area (Ruddie, & Davies, 2013).

2.6 Applying spat catching LEK to collaborative consensus building

Spat catching LEK can be applicable to consensus building from collaborative planning. Innes (1998) assert that different knowledge from participant experiences and anecdotes can improve and fill gaps within scientific knowledge. Similarly, scientific knowledge can be integrated with by separating and testing the observations and processes to identify the various interaction within the local socio-ecological system (N. A. Hill, K. P. Michael, A. Frazer, & S. Leslie, 2010). There are no literature that have linked the LEK and consensus building. Using consensus building, LEK can become a source of knowledge to create discussions with the stakeholders which ultimately leads to the co-creation of knowledge. Indeed, LEK can provide data, practical experiences of the specific local environment and give socio-ecological context. Therefore, LEK holder's knowledge can align the mutual understanding of stakeholders known as communicative rationality to the socio-ecological context of the region. As a result, the decisions by collaborative planning become more relevant and have less friction with the local residents and organisations.

Collaborative planning is built upon Habermas's notion of communicative rationality to steer away from modernist planning (Tewdwr-Jones & Allmendinger, 1998). Modernist planning was founded upon instrumental rationalism where scientific knowledge and deductive logic dominated the planning field. Communicative rationality refer to reasonings developed by mutual understanding emerging from intersubjective communications in a group of people who were at the same place and time (Healey, 1992; McGuirk, 2001). As a result, collaborative planning develops integrated knowledge arising from exchanging perspectives, values and life experiences (Healey, 1993). The consensus building thus creates "shared language" across the participant to generate collective actions (Healey, 1998). Therefore LEK can be developed and used to co-create knowledge that influences outcomes.

Network power arises from consensus building and is the strength of the network of participants. The common knowledge, new ideas and actions emerge from the interconnection of participants. The network power depends on the level of interdependence in solving problem and the diversity of participants to bring various perspectives on the same issue. The participants need to listen to create space for marginalised or powerless groups and all participants must communicate in an authentic way to learn and create common concepts, shared heuristics, norms, knowledge and ultimately resolve issues that can satisfy all the stakeholders to a degree (Booher & Innes, 2002). Consequently, the social capital generated by the process of consensus building improve and strengthen network power. Therefore LEK holders who may be marginalised can be empowered through consensus process.

Some critics argued developing consensus across all the stakeholder is too idealistic. The communicative rationality assumes that all participants will be legitimate and truthful despite the difference in self-interest, value and unequal power. However, in reality, people have self-interest, have different values and inequal power that will be used to overpower other stakeholders to steer outcomes in favour of powerful stakeholders (Gunton & Day, 2003). Indeed, Tewdwr-Jones and Allmendinger (1998) argued consensus may silence powerless and marginalised groups when trying to be inclusive of all voices which give rise to flawed results. Innes (2004) concurred that flawed results from consensus building can occur but she comments that the consensus agreements are not the end result. The outcome of the consensus group is an iterative process of developing a network that continues to improve the social capital and co-creation of knowledge. Therefore consensus group may require time and space to ensure adequate social capital can be reached to improve collective knowledge and actions

Another critic also argues that power inequality can forcefully remove participants. Margerum (2002) argue that having a large group of stakeholder group reduce workability thus stakeholders need to be selected to represent the community interests. In this process, Margerum observed political movement within the group to eliminate specific individuals to remove the opposition. Innes (2004) concurred that power cannot be equalised even during dialogue. However, Innes (2004) believes that skilled facilitator can equalise the power while authentic communication takes place to share information to ensure that powerful individuals still listen to other powerless or marginalised participant.

2.7 In the Context of Pelorus Sound and Wainui Bay

Spat catching is a highly regulated activity because it requires Resource Management Act 1991’s mechanisms for allocating space for aquaculture activities in the coastal marine area and the Fisheries Act 1996’s management of harvesting fish and aquacultural products. Consequently, the regulatory environment for aquaculture is critically important for the way spat catching industry operate (Rennie, 2002, 2006, 2009, 2010; Rennie, White, & Brabyn, 2009).

This research used Pelorus Sound and Wainui Bay as the case study. Pelorus Sound is within Marlborough Sound District Council. Marine farm applications in Marlborough Sound District Council have to take natural character, social and legislative factors thus limiting the expansion of marine aquaculture. Many resource consents applications were refused due to landscape, amenity values, recreational and navigational problems (Banta, Gibbs, 2009). Accordingly, the expansion of aquaculture is limited by the social carrying capacity embedded within legislative and regulatory environment in Pelorus Sound. Pelorus Sound also have sedimentation run off and loss of adult mussel beds. Extensive adult green mussel bed within Pelorus Sound is unrecoverable and re-establishment projects have failed (Urlich & Handley, 2020).

Wainui Bay is within Tasman District Council and is chosen because it is a famous spat catching site managed by a corporate. It has only six spat catching farms (figure 1.1) and the direction and speed of water current within these sites have not been examined (Aquaculture NZ, 2020). However, according to grey literature, the Wainui Bay spat catching Group made up of corporates had lodged an application for Plan change request in 2015 to “provide certainty of mussel spat supply in future” (Sivignon, 2015).

Figure 2.1 A map of Wainui Bay from s42A report (Source: s 42A report for Private Plan Change 61)

Summary

Spat catching operation uses a longline system. The spat catching ropes are used to enable green mussel settlement. Spats are left on the spat catching site for growth for four to eight weeks. The spats are transferred to another area and the high spat losses occur. Once the spats are grown to 10 to 20 mm, the green spats are mechanically stripped from the rope and seeded to reduce the density of spats per metre. Again, the spat losses occur after seeding. Biofouling by blue mussels is the most significant for spat catching.

Generally, the scientific literature reveal that turbulence, faster water flow tend to increase the spat settlement, survival and retention. Interestingly, primary settlement can be induced by biofilm.

LEK from Berkes (2018) has controversial categorization but the definition can be expanded in terms of socio-ecological system to include SLO and collaborative consensus building. The LEK can be shaped by observation and technology used.

Chapter 3

Methodology

The Methodology chapter outlines how this research was conducted. This chapter also justifies why the study utilised the case study method incorporating semi-structured interviews, legislation, planning documents. The case study has utilised document analysis and interactive tools in semi-structured interviews to develop LEK informed conceptual diagrams.

3.1 Case study

This research explored the local ecological knowledge developed by the mussel spat catchers through their observations of the environment, the behaviour of the mussel spat, regulatory and economic pressure. A case study is a method that enables deep investigation of a phenomenon within the scope of a specific spatial and temporal context (Yin, 2014). Stake (2005) further states that the case study is utilised to discern the case to identify relationships in a real world situation. However, there are some differences in how case study research is conducted. For instance, Yin (2014) and Stake (2005) have different ideologies underpinning their approaches to using a case study method.

Yin's (2015) approach to the method is to have two different methods to accommodate either the relativist or realist approach. A relativist approach assumes that there are multiple realities with multiple meanings. Thus, findings could be different from one observer to another. Therefore, the relativist approach would be most suitable for research with a team of researchers who can cross-check and validate the findings. A realist approach assumes that there is only one reality. Therefore, the findings of the observer should be an objective truth. Ridder (2017) suggests that the realist approach implies positivism because the method highly recommends developing theory before a case study is conducted. The realist approach is inappropriate because LEK can change with equipment, additional knowledge, change in environment, and observations thus is not an objective truth.

On the other hand, Stake's (2005 & 2008) use of the methodology is inherently based on social constructivism and assumes that social and historical human interactions, including oral and written languages develop the reality. Therefore, reality can be accessed through understanding the nuanced vocabulary and activities that have shaped the actions and inactions. (Stake, 2005 & 2008). As a result, the worldview of the spat catchers can be accessed by identifying the nature of relationships between the local community and the regulatory environment. Furthermore, ecological and the economical relationship of spat catching can be captured in the method by Stake (2005 & 2008) by using social-ecological systems assumptions that the relationships of social and ecological systems existed between particular components of the human and beyond human worlds (Ostrom, 2007).

This research adopted Stake's (2005) multicase method to examine the local ecological knowledge of spat catchers. Pelorus Sound and Wainui Bay were chosen as the quintain because two places operated within different unitary councils based on two factors; geography and the differences in unitary council involved. Pelorus Sound have nuermous bays while Wainui Bay is a small area in Golden Bay and is geogarphically in different parts of New Zealand (figure 3.1). The two places operated within different unitary councils. Pelorus Sound was within Marlborough Sound District Council and Wainui Bay was within Tasman District Council. As a result, the spats catchers were seen as cases within the quintain of Pelorus Sound and Wainui Bay.

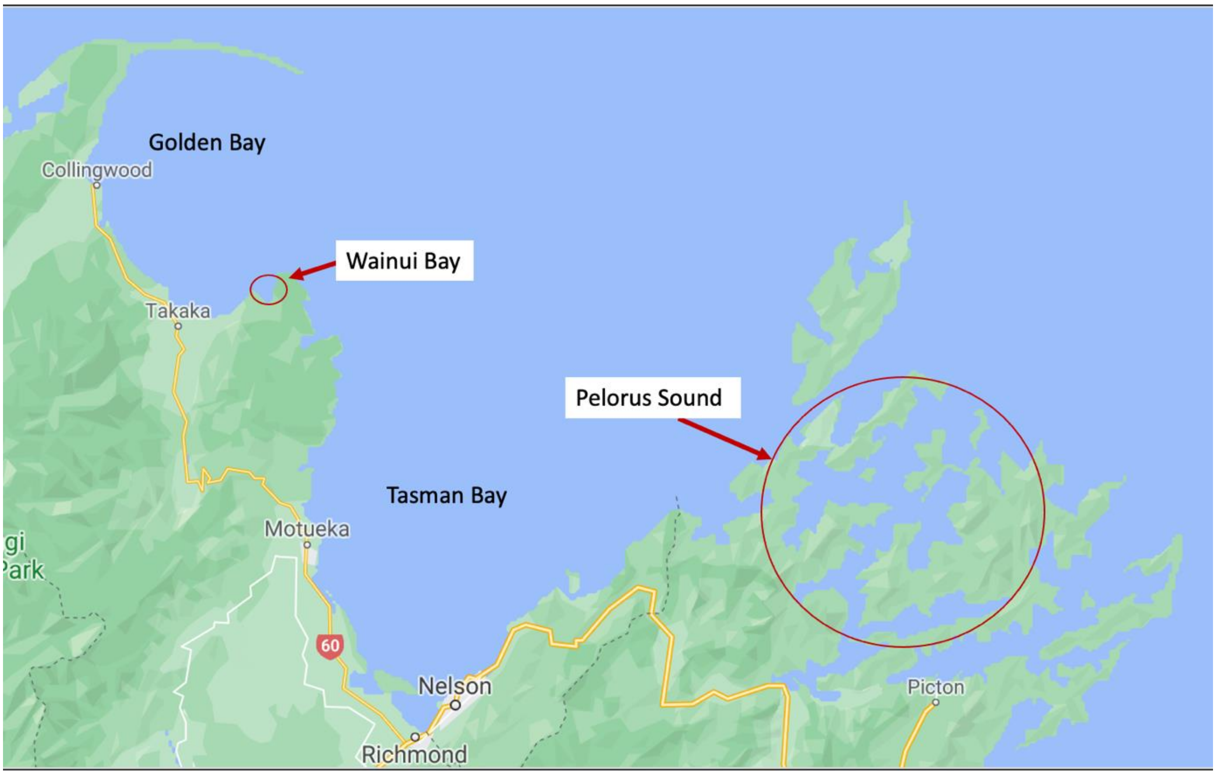

Figure 3.1 The map revealing location of Wainui Bay in relation to Pelorus Sound (Source: Edited image from Google map)

3.2 Snowball sampling

In this research, the initial seeds were scientists who contributed to the published mussel research and planners who were involved in the planning processes because these were readily identifiable from their publications, media coverage or positions held in industry or local government organisations. The initial scientist/planners were asked to recommend spat catchers with at least 5 years of experience, notable scientists, policy or resource consent planners. The spat catchers refer to mussel farmers who use the longline method to catch green mussel spats. Some scientists did not recommend spat catchers because they have to keep anonymity or they had confirmed that the spat catcher did not wish to be interviewed. The expectations of the snowball technique is that it enables key people to be identified through multiple referrals (figure 3.2). The names of the participants were anonymised in this research for ethical reasons (Parker, Scott, & Geddes, 2019).

It is possible that the author was able to access only a small chain. It posed a difficult challenge because there were communal spat catching sites that are owned by MFA (Marine Farming Associations). Pelorus Sound has experienced very low spat catches and many mussel farmers have left the industry due to difficulty in obtaining spats. However, the author asked the Marine Farming Association (MFA) and SC2 who was also part of MFA on the possible lists of spat catchers (figure 3.2). Consequently, only two spat catchers who fit into the criteria were identified. Therefore, it can be justified that there is a very low number of spat catchers in Pelorus Sound.

There are limitations to snowball sampling, namely selection bias and external validity. Parker, Scott and Geddes (2019) argue that the selection bias can occur because the initial seeds are small, which can distort the participation selection in terms of gender, age or ethnic background. However, the spat catchers populations could be skewed may not be synonymous with the general population. Furthermore, the recommendations by the participant may not truly fit into the research criteria. In this study, participants were asked to recommend two or more people who are spat catchers, planners or scientists who are familiar with the Wainui Bay or Pelorus Sound. By doing this, the participants can give the researcher a larger pool of potential participants who fit into the research criteria, which can reduce the selection bias.

Additionally, external validity can be limited by the small sample. The small number of spat catchers compensated because the Wainui Bay spat catcher is a prominent corporate manager who has the majority of spat catching farms in that area. Three Pelorus Sound based spat catchers were recruited because many marine farmers have left the industry or stopped catching spat due to the low economically viability of spat catching.

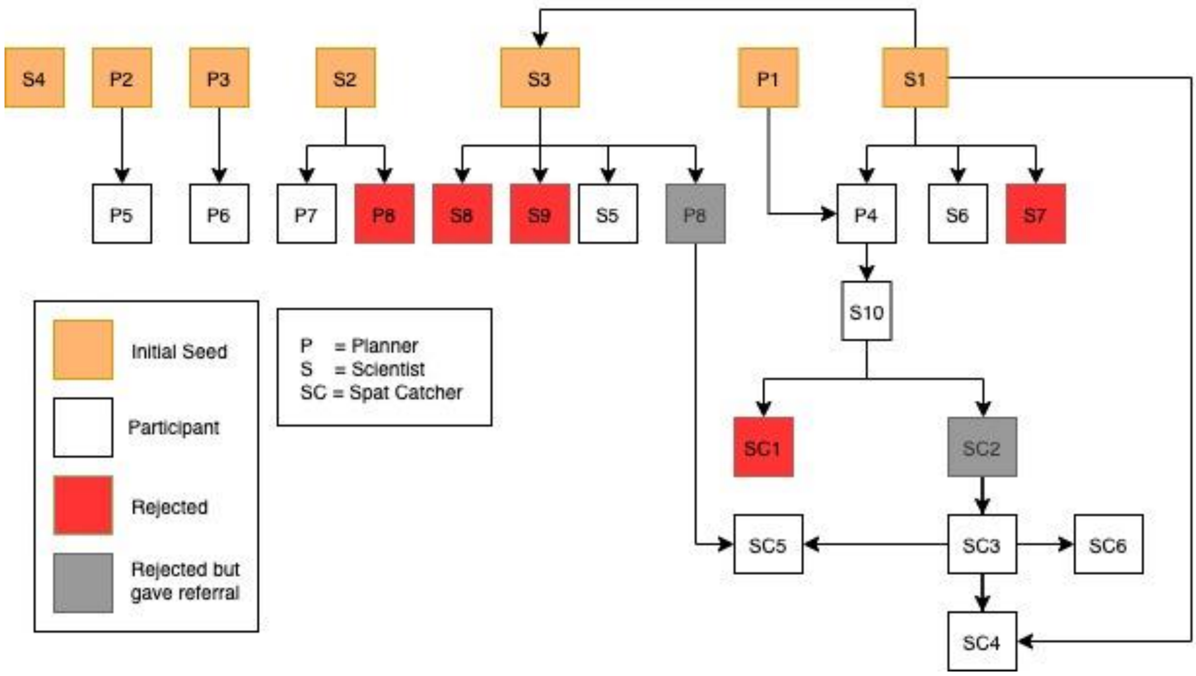

Figure 3.2 The overview of the snowball sampling.

P4 was recommended by both S1 and P4 therefore the reference by P4 is considered to be more valuable and knowledgeable thus justifies the SC3, SC4 and SC6. SC2 was part of the Marine Farming Association (MFA) therefore the referral by SC2 was considered to be a powerful and valid source. SC4 on the other hand, was referred by the MFA organisation administrator thus can be considered to be well known and experienced. SC5 was also considered a valuable source because he was recommended by P8 and SC3. SC4 received references from S1 and SC3.

3.2.1 Semi-structured interview

The semi-structured interview (SSI) was deployed to gain qualitative data from the scientists, planners and spat catchers. The type of SSI used can be described as descriptive/interpretive (McIntosh & Morse, 2015; Qu Sandy & Dumay, 2011). All interviewee were considered to be 'experts.' The scientists were interviewed on the knowledge of spats within the academic realm. The planners were interviewed on the rules and regulations relevant to spat catching activity in Marlborough Sound and Tasman Council. Spat catchers were interviewed to uncover the LEK to catch spat and continue spat catching within the socio-ecological system. This research combined interviewing approaches from McIntosh & Morse (2015), Qu and Dumay (2011) and Adam (2015). Three sets of interview questions were developed to answer each research objective that ultimately answers the research question (Appendix A). Furthermore, the SSI incorporated interactive activity known as diagrammatic elicitation where participants and researcher annotate diagrams together (section 3.2.2).

During the interview, the SSI had several key primary question stems that were used that were followed by sub-questions. For example, the spat catchers were first asked stem questions, “What are the main environment factors that affect your spat catching?” If the spat catcher gave an appropriate answer, the questions related to the spat catchers’ response was used to uncover LEK and start discussions. However, if the answer was vague, the following sub questions were used such as “Does wind direction matter for spat catching?” If the interviewee agreed, the author asked the spat catcher to give reasonings for his answer which sets a discussion point. Therefore the SSI in this study was heavily dependent on the interviewee’s response. The scripts were not followed strictly as stated in Appendix A and considered as sets of possible discussion points (McIntosh & Morse, 2015).

The author adopted the Qu and Dumay (2011) approach to achieving rapport. Qu and Dumay (2011) stated that the interviewees should be contacted and provided the context of the interview before the interview. At least two days before the interview, the scientists received a circular annual cycle (Appendix B) and an input-output diagram was developed from the knowledge built from Chapter 2, The planners received the annual calendar, a timeline of the Acts enacted (Appendix C), the input-output diagram (Appendix D) and the RMA-FA flowchart (Appendix E). All scientists and planners were interviewed online whereas spat catchers were met face-to-face.

The scientists were first interviewed based on their academic literature. This group of people had expertise on specific parts of the P.canaliculus physiology and behaviours as opposed to providers of LEK in the usual sense. Therefore, the questions were heavily varied due to differences in expertise. The scripts were used to remind the author on inquire about any observations or anecdotes were seen in terms of spat catching (refer to Appendix A1). The input-output diagrams were used to focus both scientist and the author to specific discussions and any additional key areas that the scientists could comment on.

Planners were interviewed to discover the mechanism of rules and regulations within Marlborough Sound District Council and Tasman District Council. The input-output systems were used to uncover the planner’s current knowledge and discover any LEK that was transferred from spat catchers to planners. All planners were asked to comment on the RMA-FA flowchart and its relevance to each council.

One resource planner and one policy planner were interviewed from each council. 1 coastal planner from North Island (P7) who also recommended by S2 was interviewed mainly to understand the processes for RMA-FA coastal permit and possible reasons for not granting coastal permit. P1 and P3 were from Ministry of Primary Industries (MPI). P1 was interviewed for regulation of or mussel spat. P3 was interviewed to understand the National Environmental Standard for Marine Aquaculture (NES – MA).

The SSI data from the planners and marine scientists were used to correct and revise the input-output models. The input-output model represented the author's understanding of spat operation based on the literature from Chapter 2 and the relevant SSI data from scientists and planners.

The mussel farmers who were interviewed were labelled as spat catcher because there are mussel farmers who do not spat catching and utilise spat source such as Kaitaia spat (spats from Ninety mile beach). The spat catchers were considered as the 'experts' who holds the knowledge of spat catching. The interview questions were checked with the supervisor to ensure that the appropriate questions were made and the final version is attached in Appendix A3. SC3 was the only interviewee who received the diagram through email prior to the interview because the reference to potential participants occurred within five hours before interviews were conducted (SC4, SC5 and SC6). The circular annual cycle, the input-output diagram and the timeline of Acts were placed onto one A1 sized paper and was printed three times for safe measurement. The additional A1 prints were used for SC4 and SC5 interviews. Interview with SC6 was conducted without the printed A1 sized paper but SC6 and the author drew and annotated spat catching operations on a smartphone together have gain clarity (figure 3.4).

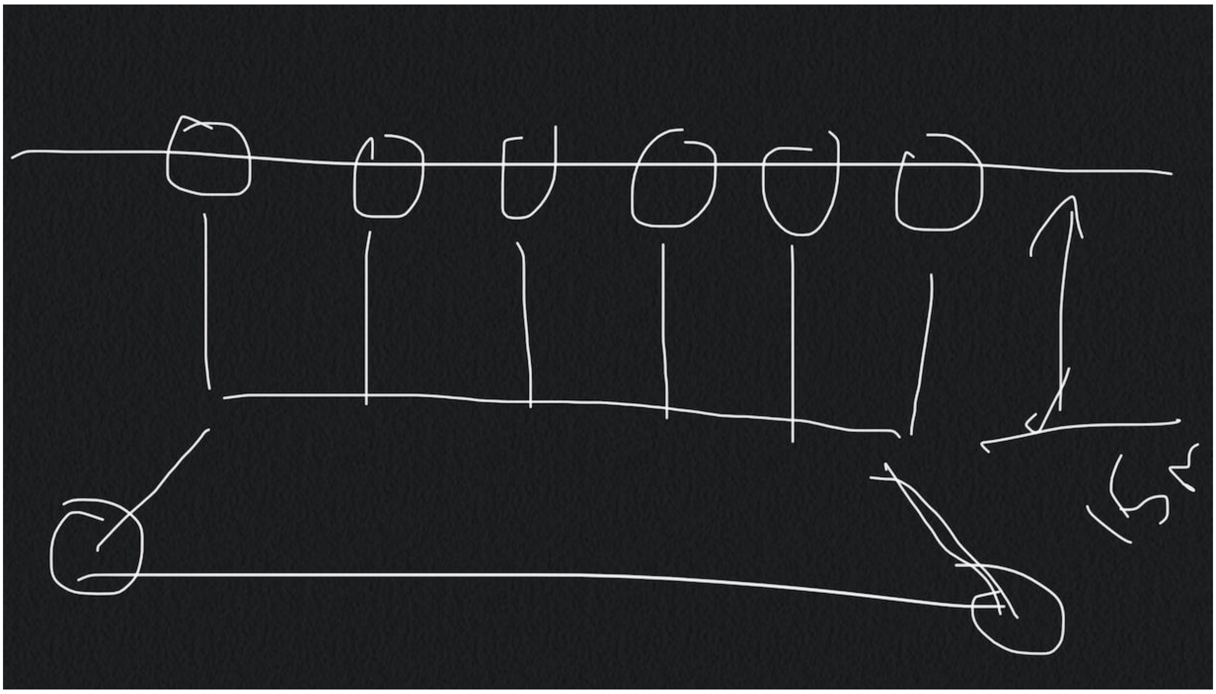

Figure 3.3 The diagram drawn by SC6 revealing deep spat catching.

Scientists and Planner SSI were conducted through video conferencing software such as Microsoft Teams, Zoom and skype. Sullivan (2012) have stated that videoconferencing is a useful tool to interview participants who are geographically far apart and for whom face-to-face is impossible or unrealistic due to budget constraint. Sullivan (2012) believes that the videoconferencing can mimic face-to-face interaction because the interview is being done at real-time and expression of the researcher, and the participants can be seen using a camera. However, Sullivan (2012) has also noted that some problems can occur due to multiple reasons, including bad sound quality, microphone, webcam malfunction, nor lagging issues during the interview. Sullivan (2012) recommended that alternative methods such as phone call interviews should be prepared. In two interviews, phone call interview had to be used. In one case, the software did not work. Thus the entire interview was done through a phone call interview. The phone call interview was challenging because the interactive component of the SSI was not possible. Furthermore, the expression of the participants could not be seen. In another case, the software's microphone and speaker malfunctioned in the middle of the interview. The interview was continued using a phone with the software's screen on. Therefore there were no differences in the interview except that another recorder was needed to record the conversation

Face-to-face interviews were done with all the spat catchers. SC3 suggested that the author should stay three days in their home (however due to circumstances, could not visit the actual spat catching spot). This enabled a better appreciation of the equipment used and the spat catching practices. Face-to-face interviews were easier to conduct because there were no technology problems and enabled participants to easily annotate the interactive diagram components easier to do.

3.2.2 Diagrammatic elicitation

The diagrammatic elicitation refers to the interactive component of SSI. Umoquit et al (2008) defined the diagrammatic elicitation as the generation of a diagram that is drawn, annotated or edited by researchers and the participants. Umoquit et al (2013) suggested that diagrammatic elicitation has two categories; participant-led or researcher-led. Participant led diagrammatic elicitation is where the participants draw a diagram from blank paper. Researcher led diagrammatic elicitation refers to where the researcher draws a diagram during the data collection process for discussion, or the participants edit a researcher-prepared diagram. According to Umoquite et al (2008), researcher-led diagrammatic elicitation increased the number of insightful comments compared to the participant-led. They considered the researcher-prepared diagram is less stressful for the participants because the participant can focus on editing and giving insights rather than focus on drawing a comprehensive diagram.

In this research, the researcher-led graphic elicitation was adopted as a method of capturing LEK. A conceptual input-output diagram that has regulatory, scientific and spat catching operation was first developed from Chapter 2 and document analysis of planning documents, legislation, policies and rules. A timeline that shows different legislation being developed and a diagram showing the annual cycle of spat catching were also developed. The findings from scientists and planners SSI were used to improve the conceptual diagram before interviewing the spat catchers.

The diagrammatic elicitation was a useful tool because it essentially incorporated most of the interview questions. During the video conferencing, All the participants (scientists and planners) were immersed because the words in each box of conceptual input-output diagram became a point of discussion, correction and explanation (figure 3.4).

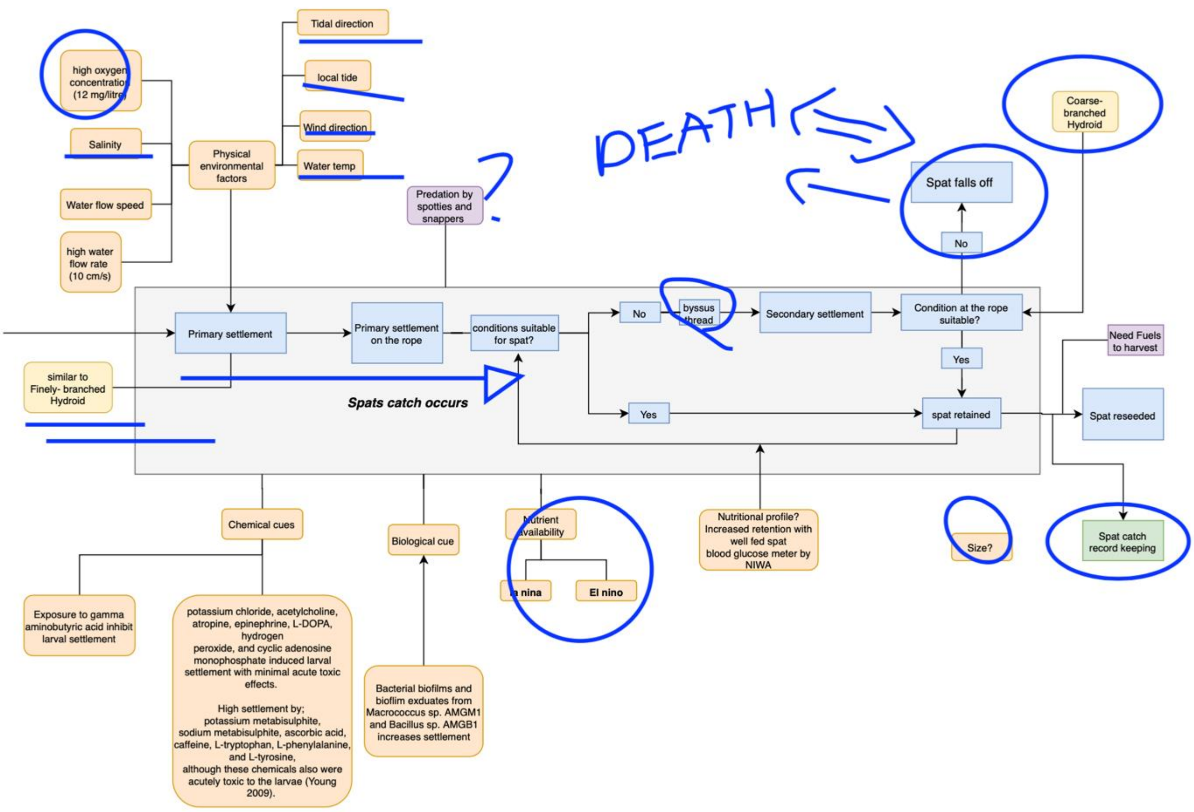

Figure 3.4 The annotation done by the author during the online interview with S6.

On the other hand, the spat catchers became serious and sometimes impressed when they had seen the diagram. Spat catchers were able to identify the depth and breadth of the knowledge developed from Chapter 2, findings from scientists, planners and planning documents. As a result, diagrammatic elicitation facilitated and enhanced the rapport during the interview. SC5 did some drawings (figure 3.5). SC3 preferred eye contact but pointed at certain boxes in the diagrams. SC4 preferred not to draw because the interview had to take place at the wharf in a Bay[1] after sunset. Whenever the spat catchers did not draw or annotate, The author did the annotation at their direction in an iterative process that the author used to confirm my interpretation of the spat catcher's response.

[1] Name of bay removed to protect the anonymity of the spat catcher

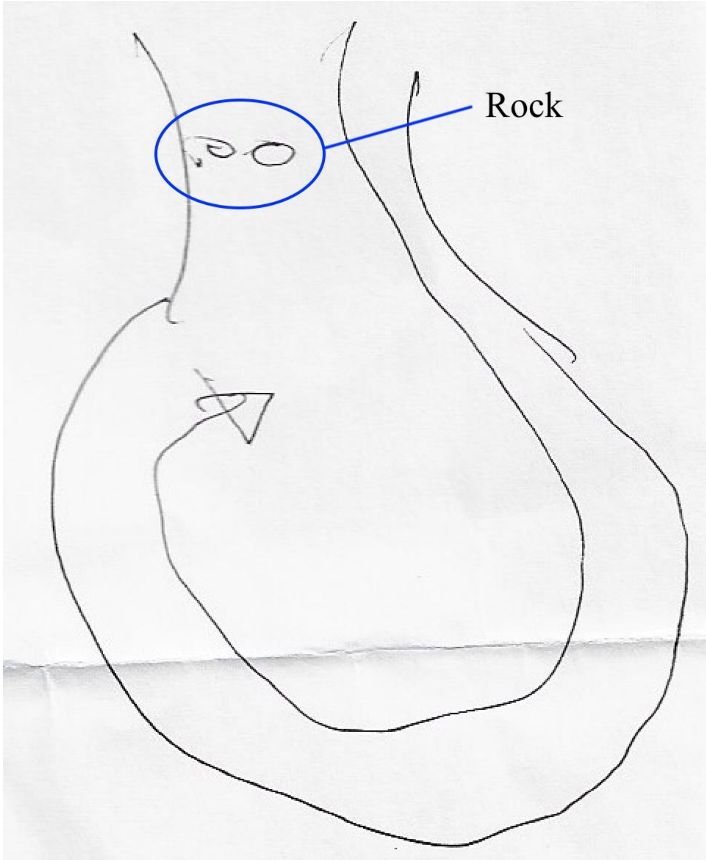

Figure 3.5 The diagram of eddying current in Wainui Bay annotated by SC5 by drawing rocks.

However, during the videoconference SSI, the interactive activity was severely limited because the software drawing tool was awkward and difficult for the participant. The participants sometimes couldn't understand how the annotation tool could work, and it was challenging to write or annotate using a mouse (figure 3.3). In this sense, face-to-face activity enabled the participant to annotate or draw a picture to understand. To mitigate this problem, the author used the diagram as a guideline for the online interviews and annotated for the participants by underlining the boxes with an annotation tool (figure 3.4). If the author could not understand their concepts, they would draw on paper and showed it to the camera for the record.

3.2.3 Transcription

Transcription refers to the process of faithfully reproducing the oral data such as interviews to a readable text. Halcomb & Davidson (2006) states that transcription is required for the reliability, validity and veracity of qualitative data. However, Halcomb & Davidson (2006) further states that the transcription requires too much effort as it could take six to seven hours of work to replicate the audio file as text.

Markle et al (2011) suggest the researcher can consider transcription as a chore and as a result accelerate transcription process at the expense of transcript quality. Unfortunately, accelerating transcription may introduce major errors in the findings. As a result, the written transcription may not reflect the oral data. Furthermore, transcripts are considered to be selective representations of oral data because Markle et al (2011) found that two graduate students who were given the same oral data produced different transcriptions that varied in quality and consistency. Therefore transcription also produce personal biases.

The SSI data was partially transcribed by reflectively watching and listening to the video of the videoconference and the audio of face-to-face meetings. The author have only transcribed the response of the participants that are directly relevant to the research questions and the research objectives. This technique was faster and efficient and the author did not have to write down his own responses during the interviews.

The transcribing was done as soon as the data and time were available, usually within a few hours of recording. The SSI data was reflectively watched and listened to a second time to minimise the errors such as typing errors or wrong words and to check whether there were any other relevant parts that should have been transcribed to answer the research question. During the transcribing, the videoconference recordings were easier to summarise than face-to-face audio recordings because videoconference records can replay the visual aspects which show the annotation of the diagram.

3.2.4 Qualitative Content Analysis

The qualitative data acquired from SSI was analysed using Qualitative Content Analysis. Mayring (2014) has developed an exploratory qualitative content analysis approach called 'inductive category development' and has noted that it has been one of the most common procedures of qualitative content analysis. In the inductive category development, not all materials are regarded for analysis; therefore, categories are developed for parts that are relevant to the research. The aim is to summarise the category directly from the material itself. However, it still aims to develop categories from a theory and associated research questions.

Elo & Kingäs (2008) outlined the inductive qualitative content analysis process where the transcribed texts were open coded, creating categories and abstraction. The open coding process refers to writing notes and headings while reading the transcription of the oral data. Elo & Kyngäs (2008) state that the transcribed materials need to be repeatedly read to describe all aspect of the content. In addition, all the content needs to be coded. The categories need to be formulated through the researcher's interpretation to categorise codes. Abstraction is required to formulate a general description of the research topic through generating categories.

The author mainly adopted Mayring's approach because the method by Elo & Kyngäs (2008) depend highly on fully transcripted data. The data were categorised from the interview questions that satisfy the research objectives and the research question. Each category was summarised and was used to triage with analysed documents such as chapters of Marlborough Sound Resource Management Plan.

3.2.5 Document Analysis

Bowen (2009) states that document analysis refers to a systematic method of identifying, selecting, reviewing or evaluating documents to gain relevant knowledge. In Bowen (2009)'s definition, the document is a text with images that have been written for a specific purpose. Bowen's method of document analysis was in three phases; skimming, reading and interpretation. Skimming is a superficial reading to understand whether the content within the documents is relevant to the research. If the document is necessary, the document is read and examined in detail to extract the relevant data. The extracted data are paraphrased and summarised without using the exact wordings from the documents.

This research adopted Bowen's approach. The relevant parts of the documents were highlighted and summarised. The summaries were used to paraphrase and triaged with qualitative data and quantitative data presented in Chapter 3.

3.2.6 Feedback

The conceptual diagrams were improved using LEK from spat catchers and findings from scientists and planners. The conceptual diagrams were sent to planners to identify whether the conceptual diagram developed from this research is useful for planning. The planners were asked to comment on how the conceptual diagram could be improved. The author asked for consent for feedbacks during the interview. Only P5 had refused. Due to time constraints, emails were sent to the planners (P1, P2, P3, P4, P6, P7). There was no reply from P4 thus five feedbacks were received.

The email asked; whether the conceptual model could be used; a degree of usefulness out of 10 (ten being most useful); an outline of advantages and limitations. Only three planners gave a usefulness score therefore the useful score was not analysed.

3.2.7 Triangulation

The triangulation is useful because the qualitative data can be used to cross check and give a more complete understanding of the LEK held by spat catchers (Thurmond, 2001). Triangulation of data was done in 'within method' where multiple qualitative data can be triaged together(Denzin 1970).

The study triaged multiple qualitative data from the interview, the feedbacks, diagrammatic elicitation, legislature, policy and planning documents.

3.2.8 Summary

The study used mutlticase method derived from Stake (2005). The quintain was based on the unitary councils that the areas were under (Marlborough Sound District Council and Tasman District Council). Therefore, the Wainui Bay and Pelorus Sound had to be distinguished. The scientists and planners became part of the study to find the current scientific understanding and regulatory environment for Pelorus Sound and Wainui Bay and the findings were used to make a more comprehensive input-output model before interviewing with the spat catchers.

The snowball sampling was deployed to find scientists, planners and spat catchers. The SSI was conducted with interactive components to develop a more complete understanding. The interview data, the feedback for the input-output diagram, the diagrammatic elicitation, legislature, policy and planning documents were all triaged together to understand the LEK within the socio-ecological system.

Chapter 4

Legislative and Regulatory Findings

This chapter aims to contextualise current legislative and regulatory landscapes and identify whether the legislative and regulatory environment changes had impacted the spat catchers' LEK. The key legislation analysed were the Resource Management Act 1991 (RMA), Fisheries Act 1996 (FA) and the Aquaculture Reform Act 2011 (ARA 11). These Acts establish the current planning system on granting coastal permits for existing spat catching farm and new water space. The chapter also analyses the New Zealand Coastal Policy Statement, the regional policy statement and the regional plan and proposed regional plan from each Marlborough Sound District Council and Tasman District Council. Lastly, comments from planners and spat catchers are included to show the regulatory landscape. This chapter opens with identifying and analysing the relevant Marlborough Sound District Council planning documents for the Pelorus Sound context and Tasman District Council for the Wainui Bay context. Subsequently, the chapter gives context to activity status and addresses the confusion created by the removal of Aquaculture Management Areas (AMA) and relevant provisions to NZCPS. The next section gives context coastal permit pathway for new water space. The next section gives context to the Pelorus Sound and Wainui Bay regulations that apply to obtain a replacement coastal permit for an existing marine farm.

4.1 Recognition and analysis of relevant legislation and regulation

The relevant Acts included the Resource Management Act (RMA), Fisheries Act 1996 (FA) and Aquaculture Reform Act 2011 (ARA 11). RMA is the key legislation for granting resource consent for both a replacement coastal permit and a new coastal permit. Within RMA, the search term, "Aquaculture" was used to identify the relevant sections. These sections also lead to relevant sections within FA 1996. Interviews with planners (P1 and P2) confirmed that the ARA 11 was significant because it removed the concept and processes for creating AMA that had been set out by ARA 2004. RMA 1991 sets out the hierarchy and its purpose in Part 2. This should be given in effect by the NZCPS 2010 in the coastal environment (which includes the Coastal Marine Area – the area between the line of mean high water at spring tide and the 12nm limit of the territorial sea). The regional policy statement and regional coastal plan should implement the objectives and policies set out by the NZCPS 2010. The research focused on the relevant provisions from the NZCPS, the two relevant regional policy statements, the National Environmental Standard for Marine Aquaculture, the two regional plans, and the proposed regional plans, comments from s42A reports, AEE and hearing documents.[2] Marlborough Sound District Council have Marlborough regional policy statement (MRPS), Marlborough Sound Resource Management Plan (MRPS) and PMEP (Proposed Marlborough Environment Plan). The PMEP supposed to replace MRPS however the aquaculture chapter was missing during this dissertation research thus it followed MRPS rules in terms of aquaculture. The Tasman District Council have Tasman regional policy statement (TRPS) and Tasman Resource Management Plan (TRMP). The new plan Tasman Environment Plan (TEP) is currently being reviewed.

The s42A reports, AEE and hearing documents were first identified using google search and were confirmed or additional ones recommended by interviewees (SC1, P2, P3 and P4) (Table 1). The documents were skim read and any legislation mentioned and relevant rules were identified and read.

Planning or Hearing documents	Recommendation or Search words used
Pelorus Sound	
Decision report for Clova Bay farm	Recommended by SC1 and was identified from Marlborough SmartMap
s 42A report for Clova Bay farm	Recommended by SC1 and was identified from Marlborough SmartMap
Decision reports on Kuku Mara Partnership	Recommended by P2 and P4 and received the copy from P2.
Wainui Bay	
s 42A report for Wainui Bay for plan change 61	Google search Wainui Bay s42A report and selected “variation no- Tasman District Council” from www.tasman,govt.nz.
Analysis of consistency with the Tasman Regional Policy Statement by Wainui bay spat catching group for plan change 61	Google search “Wainui Bay spat catching trps pdf” and selected “1Private Plan Change Request by Wainui…” from tasman.govt.nz.

Table 1. The list of plan change or consent application documents that were recommended or searched.

4.2 Activity classes that categorise aquaculture activity in RMA 1991

The RMA has enabled the consent authority to categorise the activities into six different classes; permitted, controlled, restricted discretionary, discretionary, non-complying and prohibited (See Section 77A of RMA 1991). A permitted activity does not require resource consent. On the other hand, prohibited activities are not granted resource consent. The consent authority must accept the resource consent if aquaculture activity is categorised as a controlled activity. The council can impose

[2] The list of relevant Acts, policies, regional policy statement and plans is outlined in Appendix F.

specific conditions on the controlled activity (See Section 104A of RMA 1991). The consent authority can accept or refuse an application If the activity is classed as a restricted discretionary. If the consent is to be granted, the consent authority has restricted power to impose conditions over specific matters from the relevant rules from relevant plans and national environmental standards (see Section 104C of RMA 1991). If the activity is discretionary, the consent authority can accept or refuse the application. If the consent authority grants the application, it can impose any appropriate conditions under section 108 (see Section 108 of RMA 1991). If the activity is non-complying, the consent authority can accept or refuse the application, but the consent authority can only grant the resource consent application if the adverse environmental effects of the activity will be minor or that the activity is not contrary to the objectives and policies of the relevant plan or proposed plans (see Section 104D of RMA 1991).

4.3 Confusion due to Aquaculture Management Areas (AMA)

The AMA concept was developed through the Aquaculture Reform (Repeals and Transitional Provisions) Act 2004 (ARA 2004) and was later abolished by ARA 2011 (see s s 25 ARA 2011). The aquaculture reform Act 2004 introduced AMA (Aquaculture Management Areas) as a spatial planning tool.[3] Essentially, if a plan had AMAs in it then an application for resource consent for a marine farm in the AMA would be treated as a controlled activity. This provided certainty for marine farmers, but it also restricted them to only the areas where AMA had been established through planning processes (or court actions). A number existed in the Tasman district as a result of earlier court cases. Because it restricted the aquaculture activities into specific areas with a process that were outlined in ARA 2004, the length of time it took to create AMA had significantly constrained the development of aquaculture. The ARA 2011 simplified the planning processes by removing the requirement for an AMA to exist before applying for a marine farm.[3] P2 recalled that the most significant recent regulatory change for aquaculture was the removal of AMA.

P2 stated that with the Aquaculture reform Act 2004, marine farmers could not have new coastal space unless the area was in AMA and had to go through complicated plan change processes which “marine farmers found difficult.” Therefore the Aquaculture reform Act 2011 “kicked things off again”. P2 stated that no new marine farms were created from 2004 to 2011. Currently, planning documents still contain rules that utilise AMA. After ARA 2011 was enacted, the AMA rules in the MSRMP Chapter 35A no longer applied to new or current applications.

[3] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018]NZEnvC 046 at [57]

Wainui Bay was unique in terms of the AMA landscape. Historically, Wainui Bay was not included in an AMA nor AEA (aquaculture exclusion area). AEA refers to coastal areas that are not designated as AMA, where the aquaculture activities are prohibited by rules in the regional plan. Instead, the existing aquaculture activity in Wainui Bay was considered as a discretionary activity under Rule 25.1.4 of the TRMP.[4] The activity status did not change after the plan change 61.[7]

However, none of the spat catchers in Marlborough District Council commented on difficulties with AMAs or remembered it as a complicated planning process. The coastal permit process differs significantly if the applicant is applying for a resource consent for a new spat catching site on a new coastal space.

4.4 New Zealand Coastal Policy Statement (NZCPS 2010)

NZCPS is a national policy statement under the RMA 1991 to achieve the purpose of the RMA 1991 (see section 5 of RMA 1991) in the coastal environment in New Zealand. NZCPS is important for spat catching resource consent because NZCPS had not been implemented prior to the Marlborough Sound Resource Management Plan[5] and the Tasman Resource Management Plan. Furthermore, NZCPS must be given effect to by the regional policy statements and regional plans under section 56 of RMA 1991.

The environmental court had assessed the resource consent for spat catching site known as site 8553 in Clova Bay in terms of policies 6(2) “Activities in coastal environment”, 8(b) “Aquaculture”, 11 “indigenous biological diversity, 13 “Preservation of natural character” and 15 “Natural feature and natural landscape.” S 42A report for site 8553 in Clova Bay assessed the resource consent in more detail. The report used Policies 6 (2)(a), (b), (c) and (e)(i), 8, 11, 3(1), 15(b). Additionally, the report assessed the resource consent using Policy 22(2) on “sedimentation”.

In the Wainui Bay context, the Environment court similarly identified policies 6[6], 7[7] and 137[78] to be relevant for Wainui Bay plan change and future resource consents. Therefore, the spat catching operation may need to consider the visual characteristics and degradation of visual amenity caused

[4] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018]NZEnvC 046 at [21]
[5] *R J Davidson Family Trust v Marlborough District Council* [2018] NZCA 316 at [12]
[6] *Friends of Nelson Haven AN Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC 130 at [54]
[7] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC 046 at [126 - 127]
[8] Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council [2018]NZEnvC 046 at [85]

by the structure. As a result, there may be always disputes between spat catchers and local people who don't want to see the longline system that ruins their views.

4.5 New coastal permit on new water space

Under RMA, the coastal permit for new water space must include application to undertake aquaculture activities[9] and application to build spat catching structures[10]. This section will explain the RMA 1991 – FA 1996 dual coastal permit system and erection of structures in the coastal marine area through the RMA procedure. The dual coastal permit system explained in the subsequent section is also made into a flow chart to give a visual understanding of the process (Appendix E).

4.5.1 RMA 1991 – FA 1996 dual coastal permit system

On consenting spat catching farm in new water space, the consent authority receives resource consent application, must have regard to NZCPS, regional policy statement and regional plan[11]. The regional council then process to 107F and 89A pathway concurrently. 107F pathway shows how to interact with the Ministry of Primary Industries (who were Ministry of Fisheries) whereas 89A show how to interact with Maritime New Zealand and harbour masters for navigational matters on the longline structures. A copy of the application needs to be forwarded to the chief executive of the Ministry of Fisheries[12]. Furthermore, any information or report obtained under 41C, 42A, 92 or 149 are also sent to the Chief Executive of the Ministry of Fisheries[13].

Notification can be public under s 95A processes or limited under 95B processes and an application proceeds to submission process under pt 6 s 96. Under s 97, the submission closing date is the 20th working days after the notification. Under the limited notification, the regional council can close the submission earlier if all the affected people have made submissions, written approval or written notice that the person will not submit[14]. The submissions need to be sent to the Executive of the Ministry of Fisheries after the period of submission has closed[15].

After the submission, the hearing procedure occurs. The notice of the decision in the hearing must be given within 15 days after the hearing ended[16]. The copy of the final decision and any notice must be

[9] RMA 1991, s 107F
[10] RMA 1991, s 89A(1)(a)(ii)
[11] RMA 1991, s 104 (1)(a) & (ab)
[12] RMA 1991, s 107F (3)(a)
[13] RMA 1991, s 107F (3)(b)
[14] RMA 1991, s 97(4)
[15] RMA 1991, s 107F(3)(c)
[16] RMA 1991, s 115 (2)

sent to the executive Ministry of fisheries[17]. The regional council request an aquaculture decision from the chief executive under the Fisheries Act 1996[18].

There is also a concurrent application route that is lodged to the EPA within RMA 1991. Concurrent application refers to resource consent application and plan change request that is submitted together. However, it is noted that no spat catching marine farms have used this route (P4).

According to Pt 9 s 186D (2), the Chief executives for the Ministry of Fisheries set a specific deadline for information for aquaculture decision which includes a copy of the application[19], reports obtained under 41C, 42A, 92 or 149[20], submission[21], the final decision[18]. The Chief executive can also consult any people or organisation regarding various factors impacting aquaculture decisions[22]. The deadline for the information for the aquaculture decision can be extended one week or more.

The chef Executive for fishery must receive the copy of the application[23] and any fishers or organisations that may be impacted by the proposed farm[24]. When making an aquaculture decision, the chief executive must have regard to the information[25].

Within 20 working days after receiving the request for aquaculture decisions under 114 of RMA 1991, the chief executive must make the aquaculture decision[26]. However, the 20 working day does not include the consultation period[22]. The chief executive the matters considered for aquaculture decision are in s 186GB in FA 1996. The matters set out in 186GB is also known as the undue adverse effect test (MPI, 2020). The undue adverse effect test specifically concerns; the location of the aquaculture in relation to fishing areas, likely effects of aquaculture activities to the fishing, degree of exclusion of fishing by the aquaculture activity, the type of fishing species impacted, the extent of cost increase in of fishing due to aquaculture, cumulative effects of structures and aquaculture activities[27].

[17] RMA 1991, s 114(4)(a) & s 114 (4)(c)(i)
[18] RMA 1991, s 114(4)(c)(ii)
[19] RMA 1991, s 107F (3)(a)
[20] RMA 1991, s 107F(2)(b)
[21] RMA 1991, s 107F(3)(c)
[22] FA 1996, s 186D(3)
[23] FA 1996, s 186D(1)
[24] FA 1996, s 186D(1) (a-c)
[25] FA 1996, s 186E(3)
[26] FA 1996, s 186F(1)
[27] FA 1996, s 185GB

The aquaculture decision can have two outcomes; determination and reservation. If the chief executive is satisfied that aquaculture activity will not have adverse effects on the fishing, determination of the application will be made. The determination may have conditions on the coastal permit related to character, intensity or scale of the aquaculture activity. These conditions may not change or cancelled until the chief executive decides that further aquaculture decision is required[28].

On the other hand, if the chief executive decided that the aquaculture activity will have undue adverse effects on fishing, the reservation of the application will be made. Reservation must have reasons for reservation of the area, including customary, recreation or commercial fishing or combination. If the reservation is related to commercial fishing, the reservation must specify any fish stocks that are not related to the quota management system[29].

The aquaculture decision must be in writing and needs to be notified to the regional council, applicant or the holder of the coastal permit, people and organisation who supplied information in s 196D (1) and 186D (3) in accordance with 186H. Furthermore, aquaculture must be known and notified in the Gazette and made accessible to the internet[30]. The aquaculture decision is operative once judicial reviews are completed[31]. The judicial reviews are to be completed within 30 working days[32] and notify the relevant council of the result of judicial reviews[33]. With the aquaculture decision, the aquaculture activity can be commended in accordance with section 116A[34]. P2 states that in Marlborough Sound, the aquaculture decision from MPI has been determination. P2 observe that there was no restriction when granting determination. P2 have not experienced aquaculture decisions that were reservation. If the aquaculture decision is a reservation, the Marlborough Sound council needs to amend the coastal permit to match the reservation conditions. In the worst-case scenario, P2 states that "consent has to be reversed."

4.5.2 Erection of structures in the coastal marine area

The application to build spat catching structure needs to submitted concurrently with resource consent. The regional council must send a copy of the application to Maritime New Zealand (MNZ)[35], and MNZ needs to report back to the regional council within 15 working days[36]. The report must

[28] FA 1996, ss 186H(3)(a) & (b)
[29] FA 1996, ss 186H(4)(a-c)
[30] FA 1996, s 186H(2)
[31] FA 1996, s 186(4)
[32] FA 1996, s 186J(1)
[33] FA 1996, s 186(2)
[34] RMA 1991, s 114(4)(b)(ii)
[35] RMA 1991, s 89A(2)
[36] RMA 1991, s 89A(4)

include additional conditions for navigational matters which are placement lights in spat catching longline[37]. The regional council must send the copy back to the applicant and every people who have submitted[38]. According to P2, if there are comments from Harbourmaster or MNZ, "it gets incorporated into the Council's decision in the resource consents."

4.6 Renewing coastal permit for existing water space

The MPI is the Ministry of Primary Industries that makes aquacultural decisions. MPI cannot make an aquaculture decision related to the replacement coastal permit areas (FA1996 Pt 9A s 186GA). Replacement coastal permit includes; areas that were continuously licenced for a marine farming permit under other Acts or accepted under RMA or areas that was granted a marine farming permit from Aquaculture Reform Act. (see RMA 1991 s 107F (a) (ii) FA 1996 Pt 9A s 186GA (a)(ii) RMA 1991 s 107F (a)(i) FA 1996 Pt A s 186GA (aI(i). RMA 1991 s 107F (b), FA 1996 Pt 9A 186GA (b), RMA 1991 s 107F (c) FA 1996 Pt 9A s 186GA (c).).

The following section has outlined relevant provisions from NES, NZCPS 2010. Provisions from Marlborough Regional Policy Statement (MRPS), Marlborough Sound Resource Management Plan (MSRMP) and Proposed Marlborough Environment Plan (PMEP) was analysed for Pelorus Sound context. Provisions from Tasman Regional Policy Statement (TRPS) and Tasman Resource Management Plan (TRMP) was used for the Wainui Bay context.

4.6.1 National Environmental Standard for Marine Aquaculture 2020

NES for Marine Aquaculture (NES- MA) came into effect on 27th July 2020. This has a number of provisions relevant for spat catching sites. It enables the regional council to have discretion across the marine farms. The NES also have provisions that enable the regional council to change the activities (Appendix E). P6 and P5 saw the NES as "a toolkit" for regional councils. Under the NES for marine aquaculture 2020, MPI does not have any power because the undue adverse test was already done on the application previously (P6). P6 noted that "if there is a change in species, the application needs to go through the undue adverse test again." The NES for marine aquaculture 2020 does not apply to the Tasman district, and Wainui Bay spat catching farms[39]. Therefore Wainui Bay area resource consent cannot apply NES whereas Pelorus Sound could be subjected to NES. However, P5

[37] RMA 1991, s 89A(3)
[38] RMA 1991, s 89A(5)
[39] Resource Management (National Environmental Standards for Marine Aquaculture) Regulations 2020, r 11(2)(a)

stated that the NES for marine aquaculture is a tool that they see as being able to be utilised, but that is not enforced.

If the spat catching farm is currently in an inappropriate area (inappropriate area refers to the coastal marine areas that are not allowed aquacultural activities under policy statement, plan or proposed plans from 1st January 2019), the farm is a discretionary activity[40]. Furthermore, the NES enables the regional council to have more demanding rules in its plan or proposed plan for replacement coastal permit under r 12[41].

If the spat catching farm is currently in an appropriate area, it is a restricted discretionary activity. According to r 14(2), the spat catching activity can remain restricted discretionary for applying for a replacement coastal permit if the applicant holds the current coastal permit for the existing spat farm. The applicant needs to confirm that aquaculture activity will be carried out in the same area and site, use the same structures, and farm the same species. Additionally, the application requires views of Tangata Whenua. As a result, the applicant needs to undertake the process outlined in Schedule 6 within 12 months of applying resource consent and the report required by clause 5 of Schedule 6[42]. The NES has not outlined when the report must be handed in. If the application did not undertake the process outlined in schedule 6 within six months or did not include the report in clause 5, then the r 18 applies and need to consider the effects of the spat catching activity on “Tangata Whenua values.” NES also have enabled the regional council to have more lenient rules around r 14[43]. Therefore, it shows that NES definitely enables indigenous stakeholders to be taken into account by the views of ‘Tangata Whenua’. However, the process of this is unclear and P6 have agreed. The outcome NES-MA can be seen as unclear as there are no known councils that have decided to adopt this approach.

A replacement coastal permit application must consider additional matters under r 14 if the marine farms are located within an outstanding area. The matters also need to include effects of the activity on the “values and characteristics” that make the area, feature or landscape outstanding and need to apply any additional matters from r 18 and r 19.

For r 14 consenting pathway, replacement coastal permit must not be publicly notified or only given limited notification if Tangata Whenua views were given and the report was sent along with the application. The application can have limited notification if the applicant has not taken the

[40] Resource Management (NES for MA) Regulations 2020, r 12
[41] Resource Management (NES for MA) Regulations 2020, r 13
[42] Resource Management (NES for MA) Regulations 2020, r 15(1)
[43] Resource Management (NES for MA) Regulations 2020, r 23

consultative pathway process outlined in Schedule 6 or did not include the report required by cl 5 of schedule 5[44].

Realignment of an existing farm to an area that is appropriate for aquaculture is a restricted discretionary activity[45]. The replacement coastal permit needs to follow all the requirement set in r 16 (3). Like r 14, r 16 also requires views of Tangata Whenua[46]. If the applicant did not undertake the process outlined in schedule 6 within 12 months or sent the report required by clause 5 of schedule 6, then the r 18 applies and need to consider the effects of the spat catching activity with "Tangata Whenua values." If r 18 applies, there are additional matters over which discretion is restricted in r 22(2). However, the NES enabled the regional council to have more lenient rules for r 16[47]. P6 stated that realignment is not a problem from her experiences from Tasman Council for the spat catching farms.

There are Part 4 concerns any marine farms that are trying to change consented species for catching or harvesting. However, this part only applies to coastal permit that was consented prior to the enactment of NES for MA 2020. Part 4 does not apply to the marine farm that only spat catching or adding spat catching to an existing marine farm. This research assumed that the replacement coastal permit for spat catching farm will be solely for spat catching and would not change or add any species.

None of the spat catchers was aware that NES for MA 2020 was enacted and can be applied by the regional council.

4.6.2 Marlborough Sound Council to Pelorus Sound context

It is highly likely that resource consent regarding Pelorus Sound spat catching farms will be on replacement coastal permit on existing water space because P2 did not recall "any application for establishing new spat catching farms." (P2). P2's statement was synonymous with P4 and explained further that "all the available space that will ever be allocated to mussel or marine farming has been allocated. It is unlikely that there will be additional water space granted. The balance has been reached."

Currently, the aquaculture chapter for the PMEP (Proposed Marlborough Environment Plan) is still being drafted (P2; P4). Hence the rules from Marlborough Sound Resource Management Plan (MSRMP) are still operative. In MSRMP, The aquaculture activities are not distinguished therefore

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[44] Resource Management (NES for MA) Regulations 2020. r 24(2)
[45] Resource Management (NES for MA) Regulations 2020, r 16(1)
[46] Resource Management (NES for MA) Regulations 2020, r 17
[47] Resource Management (NES for MA) Regulations 2020, r 23

spat catching, spat holding, or any other aquaculture activities such as salmon farming are all "fall under definition of marine farming." (P2). In MSRMP, marine farming is "an activity of breeding, hatching, cultivating, rearing or on growing of fish, aquatic life, or seaweed for harvest." (see Definition Chapter 25). Spat is characterised as aquatic organisms that are grown for mussel farms. As a result, the SmartMap in Marlborough website did not categorise the aquaculture activities.

Spat catching farms can be in two different zones; Coastal Marine zone One (CMZ1) and Coastal marine zone 2 (CMZ2). P2 stated that in 1999, the Council and the community had reached a solution where it demarcated marine zone 1 and marine zone 2. Most coastal farms are in Marine zone 2. The spat catching farms previously authorised by RMA 1991 or Marine Farm lease or licence from Marine Farming 1971 is considered controlled activity under 35.2.5.1 standard. The controlled activity status is retained when applying for a replacement coastal permit if the applicant is "not changing species, not changing structures, not changing area or location." (P2).

According to 26.11.1.4 (c) in MSRMP, non-complying activities for marine farming include any permitted, controlled or discretionary activities that cannot comply with the specific conditions, standards or terms. The condition and standards are as specified in rule 35.2.5.3 for controlled activities, rule 35.4.3.9 for discretionary activities and limited discretionary activities in rule 35.3.1. The non-complying activity must pass at least one of the "gateway tests" s 104D RMA 1991 with the relevant rules in MSRMP to gain a replacement coastal permit[48].

The replacement coastal permit assessment for existing spat catching farm involves NZCPS, MRPS, MSRMP and PMEP. (See Decision report Clova Bay). The NZCPS included all the provisions seen in section 1.4 of this chapter. The relevant policies in MRPS included policy 5.3.11 related to biodiversity, policy 7.1.7 related to amenity, 7.1.10 related to appropriate scale and location of the marine farm, policy 7.2.8 on appropriate usage of the coastal environment, policy 7.2.10 related to public access and recreational usage, 8.1.5 related to the promotion of nature and character of landscape of the area, 8.1.6 related to preserving the natural character of the coastal environment. (Decision report Clova bay). The relevant policies in MSRMP included Policy 2.2.1.2 in Chapter 2 Natural character, Policy 4.3.1.2 in chapter 4 (Indigenous vegetation and habitats of indigenous Fauna, Policy 8.3.1.2 in Chapter 8 Public access, policies 9.2.1.1.1, 9.2.1.1.2, 9.2.1.1.7, 9.2.1.1.1.15, 9.4.1.1.1, 9.4.1.1.9 in Chapter 9 Coastal Marine and policy in 19.3.1.1 in Chapter 19 Water transportation. The relevant policies in PMEP included policies 5.10.3 in Chapter 5 Allocation of

[48] *Clearwater Mussels & KJB Marine Farms Limited v Marlborough District Council* [2016] NZEnvC at [232]

public resources, policies 6.2.7 in chapter 6 Natural Character, policy 7.2.4 in Chapter 7 Landscape, policy 13.2.6 in Chapter 13 Use of the Coastal Environment.

The spat catching farms specified as controlled activities are highly likely to undertake the limited notification process instead of a non-notified procedure. The high court has stated that despite being a controlled activity, mandatory notification provisions in the Act could still apply in particular ss 95B and 95E. Under 95B (1) it states that it must decide whether person or groups are affected by the activity. If there are more than minor effects on a person or groups, they should be notified. However, the matters that will contribute to assessing the effect will be on matters that the Council has some discretion illustrated in 35.2.5.3[49].

According to P4 if the marine farms went to hearing, it would cost the applicant from $50,000 to $60,000, which indicated that replacement coastal permit processes are expensive. SC3 added that the benthic survey required for assessing the effects of marine farms is expensive and that RMA 1991 had brought too many procedures, leading to costs. On the other hand, SC4 stated that he agreed that RMA 1991 had become too complicated but did not have problems with the procedures.

4.6.3 Tasman District Council to Wainui Bay context

As mentioned before, Wainui Bay is not subject to NES. Historically, Tasman District Council did not include the Wainui Bay in AMA (aquaculture management area) or AEA (aquaculture exclusion area). the aquaculture activity in Wainui Bay was considered to be discretionary activity under Rule 25.1.4 of the TRMP50. The activity status did not change after plan change 6151.

The activity status for mussel spat catching and spat holding is regarded as a discretionary activity[52].

In deciding on an appeal of the proposed, the Environment Court decided that provision for spat catching and holding in defined Wainui Bay area as a controlled activity would preclude examining the effects of this activity on the Wainui Bay landscape or natural character or other matters when any application for renewal of the permit after 202453. Therefore, the activity of spat catching in

[49] *Clova Bay residents ASSN INC v Marlborough District Council* [2016] NZHC 2017 at [26-32]
[50] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC 046 at [21]
[51] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC046 at [126-127]
[52] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC046 at [126]
[53] *Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council* [2018] NZEnvC046 at [131]

Wainui Bay was classified as discretionary activity thus replacement coastal permit not guaranteed in the next resource consent application .

The environment court stated that future resource consent for Wainui Bay would require the rules from TRMP 25.1.4.4 and include matters presented and assess positive and adverse effects under s 3 and s 104(1)(a) RMA 1991. Wainui Bay is subject to Policy 22.1.3.2 which states that the spat catching and spat holding activities in Wainui Bay require resource consent and map of the site[54]. The environment court emphasised that most relevant parts in TRPS are the general objective 4 and 5. The environment court also emphasised Objectives 6 and 8 of the NZCPS[55].

4.7 **Summary**

The legislative finding showed that the removal of AMA was significant for Pelorus Sound and complicated issues for Wainui Bay. P2 stated that no new marine farms were created from 2004 to 2011 because marine farmers found the planning procedure difficult. Currently, planning documents still contain rules that utilising AMA but apply to current applications. Wainui Bay was an anomaly where it was neither Aquaculture Management Area nor Aquaculture Exclusion Area. The spat catching activity is regarded as discretionary activity in Wainui Bay after plan change 61.

New coastal permit for new water space and replacement coastal permit had different legislative route—the coastal permit for new water space required interaction of RMA 1991 and FA 1996. The granted resource consent under RMA 1991 can be altered or reversed by aquacultural decisions. The application to build spat catching structures are submitted concurrently with the resource consent application and is taken into account during the hearing.

The replacement coastal permit resource consent requires consideration of the New Zealand Coastal Policy Statement 2010 (NZCPS 2010), National Environmental Statement for Marine Aquaculture (NES – MA), regional policy statement, regional and, in some cases, proposed regional coastal plan. Both Marlborough District Council and Tasman District Council had used NZCPS extensively because the regional policy statements and regional plans were published before the NZCPS 2010 was established. NES for MA was recently published, which has not yet allowed aquaculture decision to take place. NES is seen by planners as a flexible toolkit rule for regional councils, however, none of the spat catchers interviewed were aware of it. Uniquely, Wainui Bay was exempt from NES. Both councils had a strong emphasis on the regional plan. Uniquely, Marlborough Sound utilised aquaculture rules in Marlborough Sound Resource Management Plan (MSRMP) because Proposed

[54] Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council [2018] NZEnvC046 at [124]
[55] Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council [2018] NZEnvC 130 at [55]

Marlborough Environment Plan (PMEP) did not currently have the aquaculture chapter. Spat catchers in Pelorus Sound were aware that the aquaculture chapter in PMEP is missing. There was some disappointment that the plan change 61 did not change the spat catching activity to controlled activity.

This chapter has identified various legislative and policy and regulatory mechanisms that are complex. The regulatory environment also includes the public notification and participation phases thus the local attitude to spat catching and mussel farms become an important issue (refer to chapter 6). Furthermore, the regulatory environment has become more complex due to the introduction of NES for marine aquaculture (refer to chapter 6). However, the spat catchers have not stated that certain rules within the plan have changed the spat catching method In Pelorus Sound. Instead, SC4's statement gives a sense that the complexities of rules and hearing procedures have increased the cost to start or renew the coastal permits for the spat catching and spat holding sites.

Chapter 5

Mussel spat catching operation findings

This research aims to see whether the LEK can facilitate planners to understand the socio-ecological environment of P. Canaliculus spat catching. This chapter presents the results and findings from both Pelorus Sound and Wainui Bay. The chapter begins with the catchers' perspectives on the advantage of utilising wild-caught P.Canaliculus (green mussel) spat and then provides a description of spat catching sites. The chapter focuses on the LEK embedded in technology utilised and spat catching processes to examine the changes in technology within the socio-ecological environment. Lastly, various environmental factors were identified from the observations that were incorporated into LEK to identify various biophysical factors and changes.

5.1 The importance of using Wild Caught P. Canaliculus spat

Using wild caught green mussel spat was perceived as advantageous by the spat catchers because mussels from different geographical areas fatten at different times (P4). Therefore the mussel farmers can utilise mussels from different origins to extend the farming operation to run 11 months of the year. P4 emphasised that the mussel farms need to operate throughout the year because manufacturing and processing is incredibly expensive if it is not constantly running. P4 also gave a vivid explanation:

> The farm cannot operate by producing 11,000 mussels for two months in a year. You can only produce tenth of that. *The whole farming operation is predicated on supplying the processing factories [emphasis added].*

SC3 stated that the Pelorus Sound fattening cycle used to be from September to the end of January. On the other hand, the fattening cycle of Kaitaia spat (green mussel spat from Ninety Mile Beach) was from January to August therefore they complemented each other. On the other hand, SC5 stated that Golden Bay mussels (which includes Wainui Bay) fatten from September to February. Kaitaia fattens before Christmas up to June. Therefore by having some of each, the mussel factories can be operated for ten and a half months of the year. The slight differences in the period of Kaitaia spat fattening suggested that different conditions by the geographical areas can result in the different fattening period despite being the same species (SC3; P4). The Pelorus spat fills a role of being out of season, but is not as important as it used to be because Kaitaia fattening occur much earlier than previous times (SC3).

5.2 Spat catching LEK does not identify P.Canaliculus source population

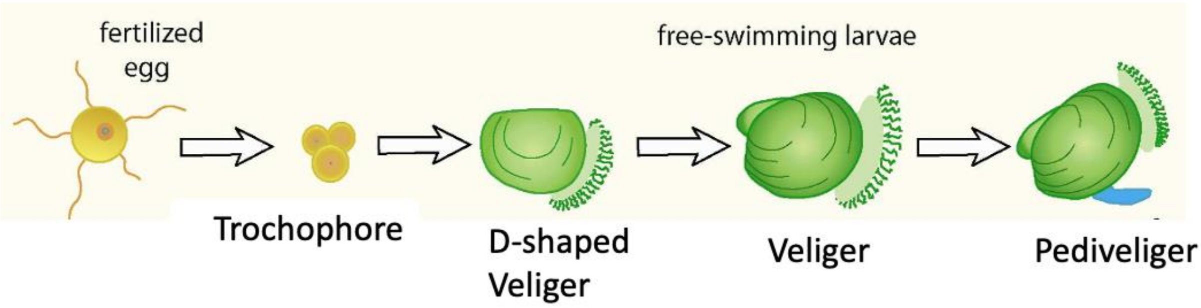


Figure 5.1 The biological process of green mussel egg to pediveliger.

The fertilised eggs become trochophore and develop to D-shaped veliger. Unlike other shellfish, the P. Canaliculus (green mussel) have a very short trochophore stage thus the change from egg to D-shaped veliger occurs within 40 to 60 hours (S2). The D-shaped veliger develops into veliger and further into Pediveliger. Pediveliger is commonly known as larvae. S6 stated that larvae can also swim, they can also choose to some extent, whether to swim up or down. These larvae undergo metamorphosis to become spat on fibrous seaweed or spat catching lines. These spats can also crawl. All the participants (including the scientist interviewed) have confirmed that the source population for P.Canaliculus larvae is unknown in both Pelorus Sound and Wainui Bay. Wainui Bay, SC5 stated that while the source of spat is unknown it could be from the West Coast. The larvae are microscopic thus “invisible (SC6).” SC6 emphasised that it not possible to predict where “the cloud of larvae will hit and settle onto the spat catching gears.” Therefore in Pelorus Sound, the altering alignment of longline structures (figure 5.2) do not seem practical

5.3 Spatfall monitoring as a key to identify reliability of spat catching sites

Pelorus Sound spat catching sites were found by “luck” in the 1970’s (SC3). Some spat catching sites were found by observations by nearby marine farmers and confirmed through constant spat sampling. SC3 gave a notable example:

> “A farmer noticed every year, when he cleaned the anchor warps, it was smothered in pure carpets of green mussels. That is how we knew that greens [green mussel larvae] come in a seasonal way.”

SC4 added that sampling frames were used on the sites to monitor the number of larvae settling onto these sites. The sampling frame was a foot long square with six to eight inch ropes. Using the spat sampling frame method, the seasonal pattern of spat settlements were understood.

Unfortunately, annual spat settlement patterns in spat catching sites in Pelorus Sound became less predictive and it became harder to retain spat. P4 asserted that the cost of using Kaitaia spat is far less expensive than actually operating a longline spat catching operation in Pelorus Sound. P4 gave a vivid context for the cost of operating a spat catching operation;

> *"Deploying a vessel, three million [dollar] vessel, with four staff on it with 650 dollar per hour. And you are spending eight, nine and ten days deploying and recovering rope. and you don't catch anything. You can blow away 100 thousand dollars and get nothing."*

Therefore spat catching is not economically viable and, according to P4, "there has not been any deployment of spat catching rope in Pelorus Sound this year (2020)" SC3 also agreed and affirm that "spats are not as viable and not as healthy as it used to be." As a result, both SC3 and SC4 have given up spat catching. SC3 further asserted that "something has changed and it is so mythical that nobody knows why". SC3 believed that there were no observable changes in the physical environment, but acknowledged that the mussel industry is not aware of various potential factors that impact green mussel larvae and spat.

Unlike Pelorus Sound, Wainui Bay spat catching is economically viable. A spat catcher in Wainui Bay observed that the spat catching was a lot more successful "30 years ago when the RMA was introduced" (SC5). S10 assumed that "eddying water within Wainui Bay" enables the larvae and spat to accumulate within the bay. Therefore the spat catching lines in Wainui Bay have multiple exposures to P.Canaliculus larvae and spat. S10 claimed that the "water current in the Wainui Bay makes the site so spectacular." SC5 agreed and claimed that the rocks at the north side of the farm give a "washing machine effect" where the ropes are continuously exposed to green mussel larvae and spat (figure 3.5). However, the water currents of Wainui Bay have not been charted scientifically (S10).

5.4 Spatfall monitoring programmes and technology central to LEK

All spat catchers have utilised spatfall monitoring programmes. Pelorus Sound spatfall monitoring programme is run by MFA (SC3 and SC5). The Wainui Bay spatfall monitoring programme is run by the company who manages the farm but the methods are exactly the same (SC5). These were central to the LEK developed. All spat catchers in this study had different spat catching equipment and configurations despite using the common longline backbone technology. Figure 5.2 and Figure 5.3 show the general longline systems that are used in both Wainui Bay and Pelorus Sound.

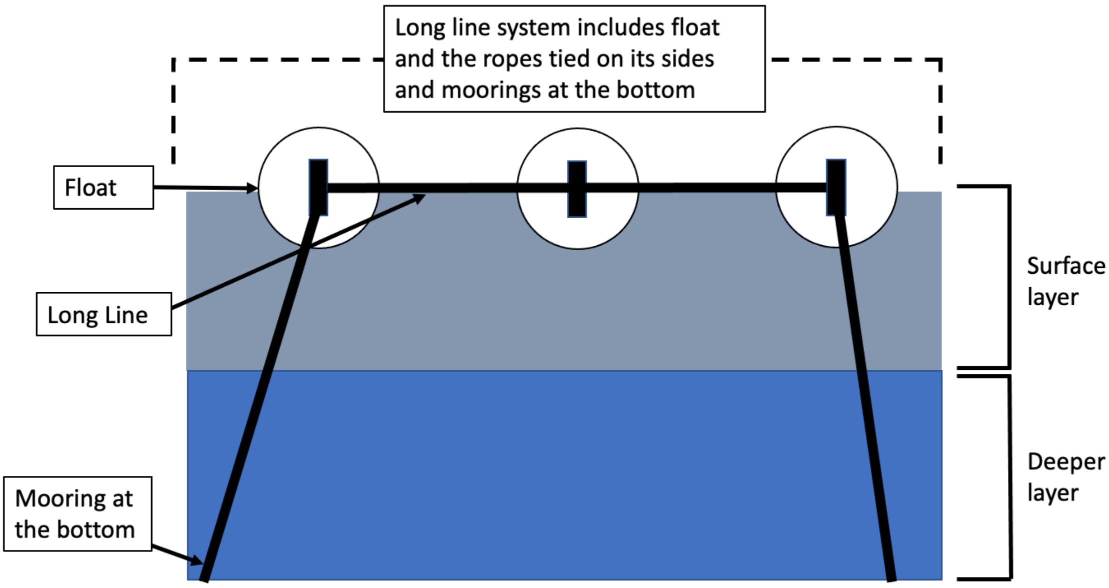


Figure 5.2 The general longline system without the spat catching equipment from side view. This diagram is not to scale.

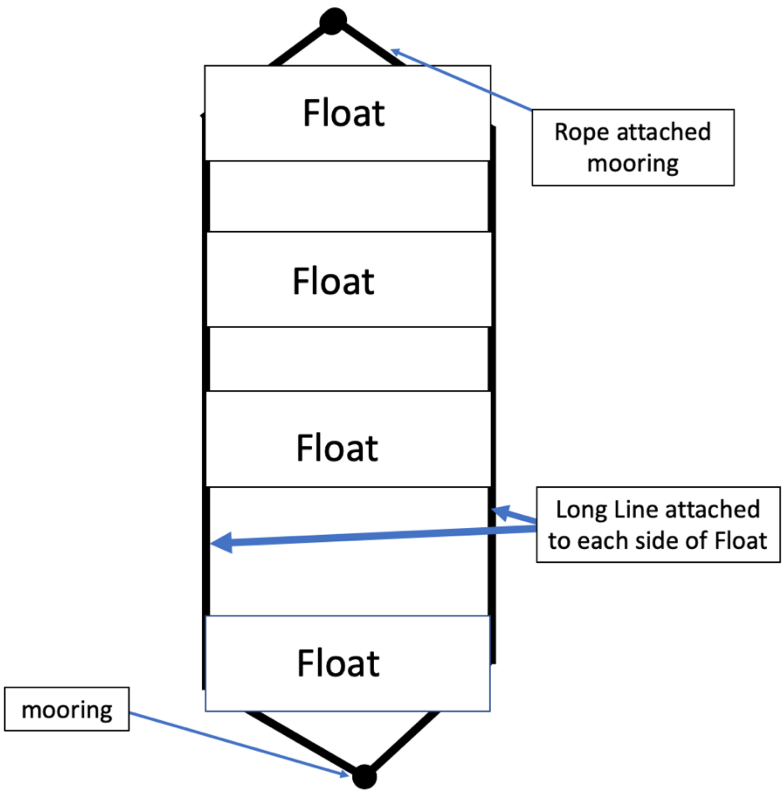


Figure 5.3 The general longline system from top view perspective. This diagram is not to scale.

5.4.1 Spatfall monitoring programme is the core part of LEK

The MFA spat monitoring programme is a weekly report that shows the average counts of green mussel spat and blue mussel spat settlement calculated to "spat count per metre of spat catching line" in various locations (SC3). SC3 and SC4 stated that the marine farmers used the spat counts to predict the spat movements in various spots. As a result, the farmers "watched these number of spat counts to determine when they should put the ropes (spat catching equipment) in" (SC3). This type of quantitative data is needed because the spat is so microscopic that it is impossible to visually observe the larval or spat settlement on the spat catching equipment until the spat has grown up to 1mm or more in size.

Similar to a stock exchange, SC3 utilised the spat monitoring programme to predict the spat movements in various bays but made his own call as to when to catch spat. SC3 assessed the spat monitoring provided by MFA to estimate spat movements of green spat and blue spat. If there are more than 500 green spat per meter, he considered it an average catch. He stated that ideally, there would be more than 1000 green spat per meter with no blues. Over the years, SC3 had found that a successful catch had up to 20 to 30 percent of blue mussel spat. Until 2000, the green to blue mussel ratio was 9 to 1, but now, in his view, it is almost 4:6. He has retired from spat catching because the spat catching is now "useless".

Furthermore, SC3 monitored his own farm using the same method as MFA, but used a net instead of lines. He stated that he cut at least two 30cm to 40cm long net from the longline and a family member used a microscope to count the number of green mussel and blue mussel spat on the net. The counts of green spat and blue spat were used to estimate the number of green mussel spat and blue mussel spat on the entire net. The numbers on the sample gave indication to stop, continue or shift the rope to a spat holding site.

In Wainui Bay, SC5 previously observed the "wind and moon", however, he stopped using this method and now exclusively uses the spat monitoring programme because it is more accurate. SC5 runs a weekly spat monitoring programme on the northern and southern end of the farm. The programme is run exactly like MFA's spat monitoring programme. SC5 stated that it has now become "quantitative work" and observed the "ratio of blues to green" very carefully.

5.4.2 Types of spat catching equipment that have changed over time.

SC3 In Pelorus Sound uniquely used plastic mesh net instead of fibrous spat catching ropes. SC3 stated that 25 years ago, a man proposed that a plastic mesh net should be used instead of ropes (photo 5.1). He refused first because he already had experimented with different kinds of plastic mesh nets which was ineffective at catching spat. However, after two years, SC3 could not catch anything on the rope therefore out of desperation, he decided to use the net which “astoundingly worked.” SC3 first used the plastic mesh net on single dropper configuration with a weight on each rope (figure 5.4) but later hung a long net continuously on a longline similar to the rope method demonstrated in figure 5.5, 5.6 and 5.7. SC3 also compared the mesh nets with different plastic hole sizes, thickness of threads and plastic materials. After various experimentations, SC3 stated that the best net was the “weakest net that had biggest holes, softer and thinner filaments” and “was the most difficult to handle” because it needed to expose to flat surface and “It would break and break.” SC3 used both the rope and net to test its effectiveness and found that the net was more successful. He observed that “nine of the ten, the net was significantly more successful than rope”. For two to three years, SC3 always set up rope and net methods to compare and eventually SC3 found himself using more net than rope. SC3 added that the “net did not catch more than rope but the spat survived better.” SC3 added that the “net likely to catch less but the number of spat retained after reseeding determines the successfulness of your farm.”

Photo 5.1 The picture of plastic mesh net.

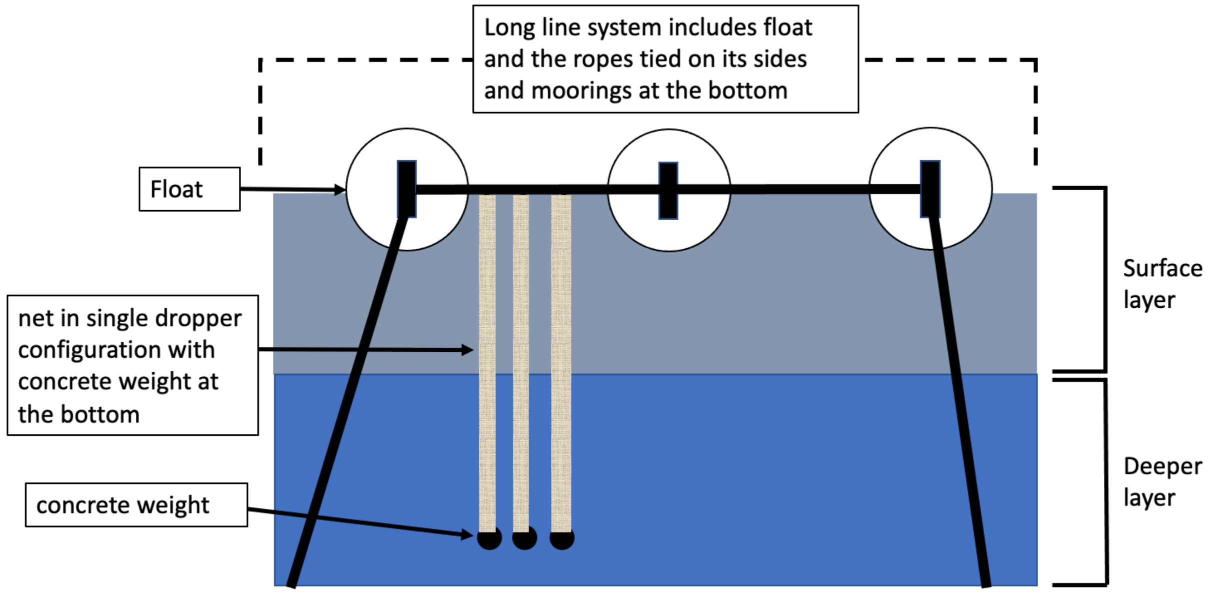


Figure 5.4 The net in a single dropper configuration

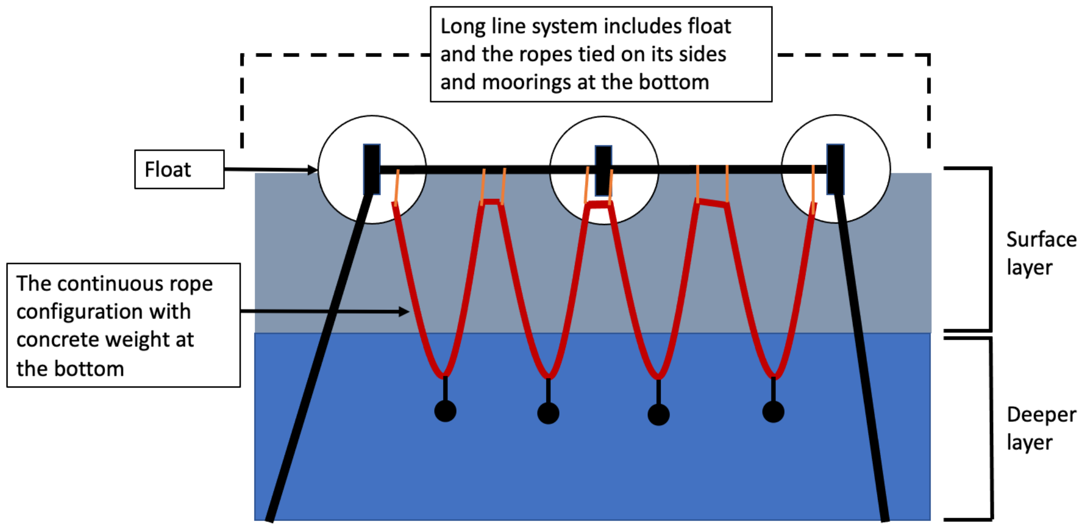


Figure 5.5 The mussel spat catching using plastic mesh net (in red) in a continuous rope configuration

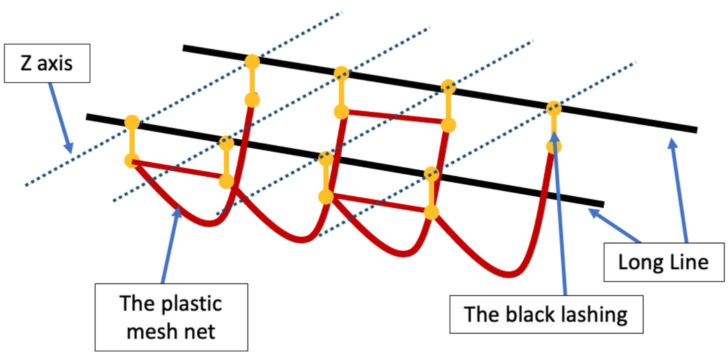


Figure 5.6 Mussel spat catching using net (in red) in a continuous rope configuration in 3D view.

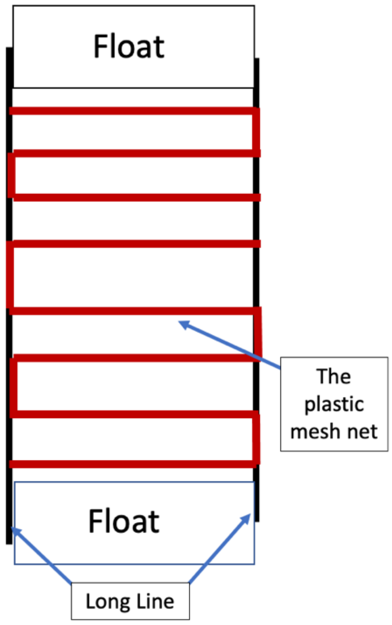


Figure 5.7 Mussel spat catching using net (in red) in a continuous rope configuration in top view.

The plastic mesh net method was difficult to use because it required concrete weights and would tangle upon itself. SC3 stated that “tremendous effort went into how to manage and strip the net mechanically over the fifteen to twenty years.” A net is very difficult to manage and strip but SC3 developed a successful system that worked economically. After the net entangles itself, it forms into a rope shape thus needs to be stretched back into net shape manually, so SC3 believes that the net method can be improved. The net needs to be self-sinking without weights and retain the net shape.

On the other hand, SC4 in Pelorus Sound stated that he exclusively used unleaded ropes in a continuous rope configuration as in figure 5.7. He used concrete weights to ensure that the rope did not float. SC4 further explained that he did not upgrade his ropes to leaded ropes because leaded ropes are expensive and none of the leaded rope varieties had the soft long fibrous quality that his unleaded rope possesses. He stated that “leaded ropes do not catch well.”

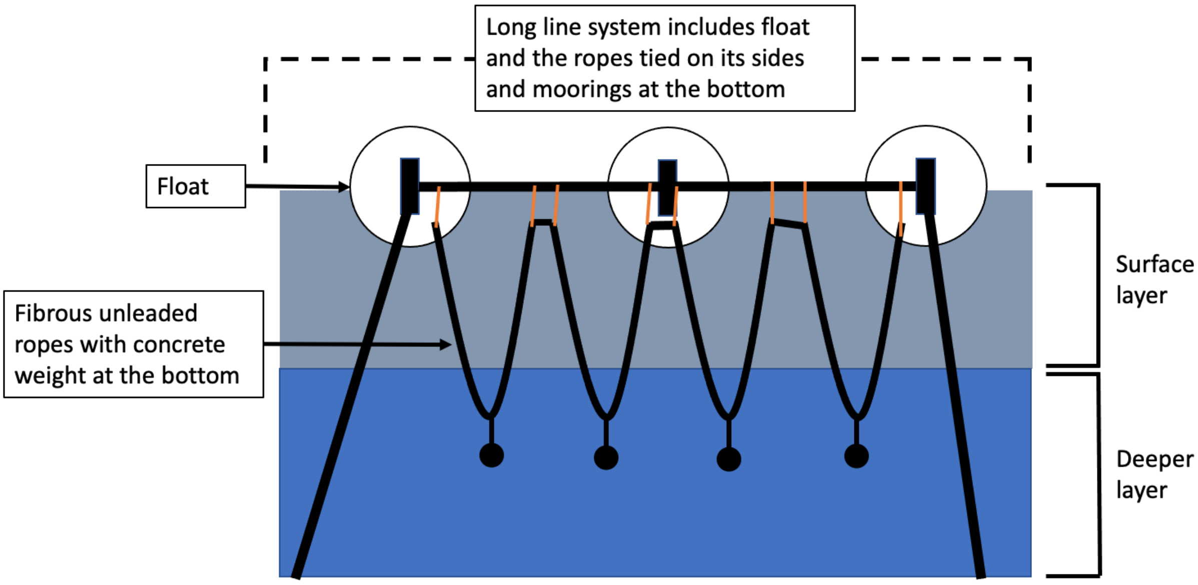


Figure 5.8 The spat catching with unleaded rope arrangement.

In Wainui Bay, SC5 preferred using leaded ropes because the heavy weight of the rope eliminates the necessity of concrete weights. SC5 clarified that using “weighted bags or concrete was labour intensive and costly and probably not environmentally friendly.” Furthermore, SC5 explained that there are two categories of spat catching ropes; continuous loop and cut loop. Continuous loop ropes refer to ropes that have uniform loops. Cut loop ropes refer to ropes that have thin long fibres without any loops (photo 5.2). SC5 explained further that cut loops are better because when mechanically stripping the mussel spat (which occurs when the sizes are 10mm to 15mm), the mussel spat can get trapped in the loops and get crushed or lost which results in five to 10 percent unnecessary spat losses.

Photo 5.2 Spat catching shown by SC5. The left picture shows cut-loop rope. The right picture shows the loop rope

The scientists all concurred that the spat catching ropes will have primary and secondary settlement processes occurring together. S2 explained that mussel larvae undergo “internal rearrangement which is known as metamorphosis or settlement” at warmer temperatures (from 19 to 20 degree Celsius). S6 agreed with S2’s views and added that in farm situations, mussel spat catching mostly occurs in summer. S2 explained that the juvenile spat in primary settlement first put threads out to hold their position and later put out the byssus thread to improve their anchoring. As stated in Chapter 2, the secondary settlement occurs when the conditions of the first settlement are found to be unfavourable by the spat. The juvenile spat let the byssus threads go and in two ways; “crawl” or “produce a strand of sticky mucus that are buoyant that act as a parachute to drift off the water column” (S2). S2 added that the secondary settlement can be repeated many times until the juvenile spat settle onto places with suitable conditions. However, the factors for the suitable condition is currently unknown because it is difficult to know whether spat are falling off the rope due to secondary settlement or due to mortality (S5). Spat catchers had no views on this., other than that they recognised that secondary settlement occurred.

5.5 Understanding Spat catching processes that have changed over time

In Pelorus Sound, the two layers of water column induced two different spat catching methods; shallow and deep spat catching. On the other hand, the Wainui Bay farm had several changes. SC5 drew a diagram to make the author understand better (figure 5.9). Initially, SC6 and his crew had used the single dropper method 30 years ago (figure 5.10) and changed to continuous spat catching ropes (figure 5.11) because the rope can be continuously stripped for the seeding phase. Subsequently, SC5 and his crew shifted to another technique (frame method) (figure 5.12). However, SC5 and his crew found the frame method was inefficient and changed back to a continuous spat catching rope method. The ropes stay in the spat catching site for up to four weeks for the spat to grow to 1mm. Subsequently, the ropes (with the spat attached) are shifted to spat holding sites for up to 6 months. These spat are stripped and reseeded onto a new rope and are wrapped with cotton. The cotton wrapped spat ropes are known as intermediate. The intermediate are stripped and re-reseeded again onto a new rope and wrapped again with cotton to be grown for mussel production. The process of seeding is detailed in section 2.3. From the spat catcher, it is understood that some farmers seed the mussel twice to reduce the density per meter (SC3, SC4 and SC5).

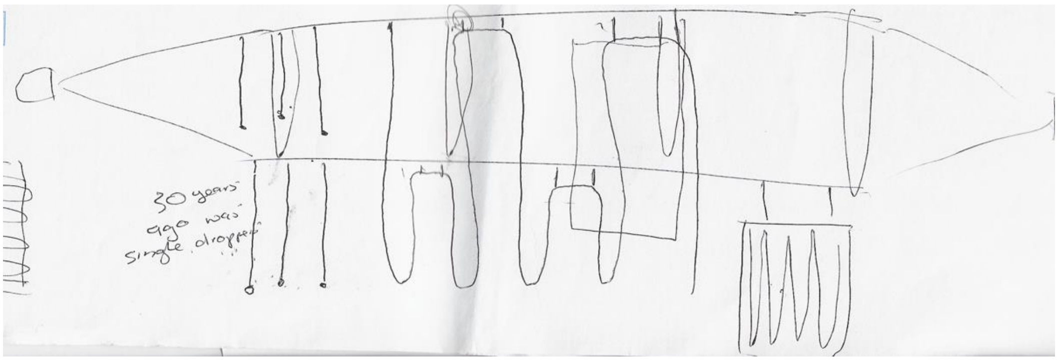


Figure 5.9 Example of SC5 drawing to explain the changes in spat catching method.

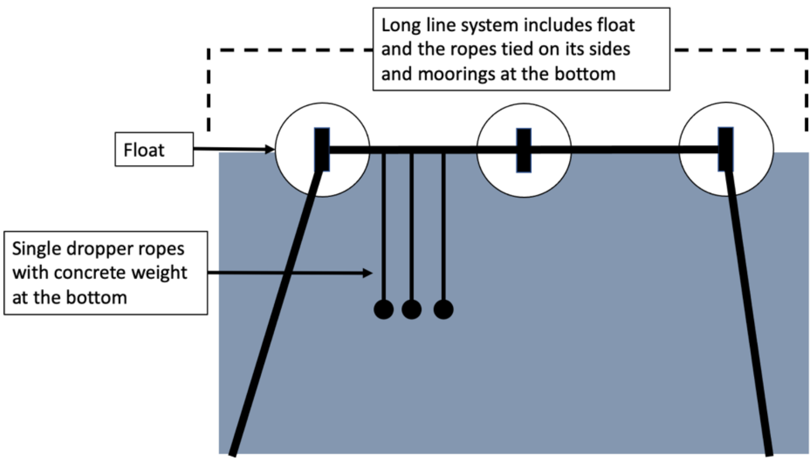


Figure 5.10 The Single dropper method in Wainui Bay.

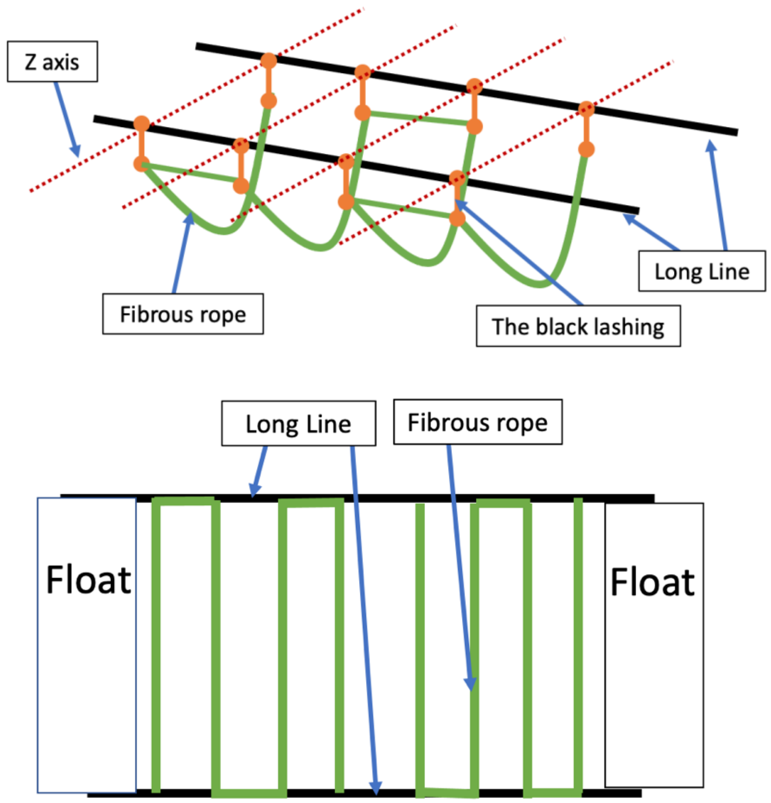


Figure 5.11 The continuous rope configuration in Wainui Bay.

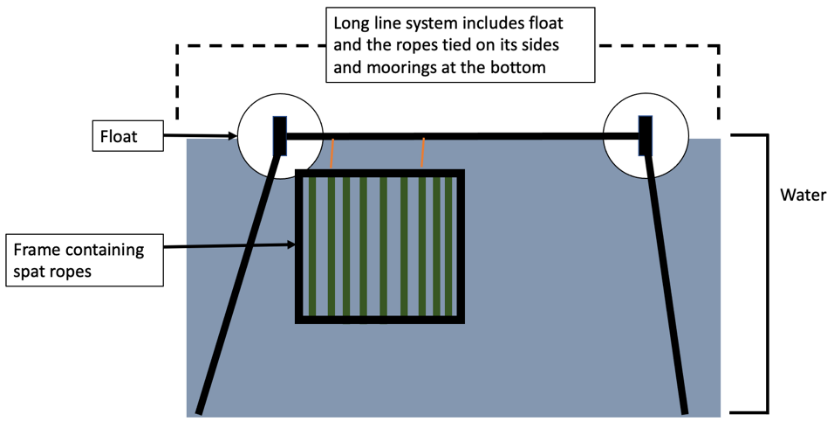


Figure 5.12 The Frame method in Wainui Bay.

5.5.1 Spat catching method

There are two layers of the water column in Pelorus Sound. S1 explained that the water column in the Pelorus Sound is stratified because freshwater from Pelorus River sits on top of the denser sea water. The level of stratification of water differs between Summer and Winter, with the freshwater on the top layer being colder in Winter and the bottom layer is warmer. In Summer, the top layer of freshwater is lighter and warmer and the bottom layer is less saline. Furthermore, the depth of freshwater can increase with high rainfall. SC3 described that the top freshwater layer as a “shallow layer” and the bottom seawater layer as the “deep layer” and stated that the shallow layer depth is around 8 to 10 metres and the separation of the two layer can be observed as a “visible saline oily layer” during summer. SC3 also noted that the two layers of water can flow differently and sometimes in opposite ways. SC3 witnessed that the longline backbone of the spat catching ropes on the surface and the backbones at 8 meter depth bowed in opposite ways. However, SC3 did not observe any noticeable differences in the water speed relative to each layer. SC3 added that green mussel larvae “are in the deeper layer by preference” and SC4 concurred. Because the spat lives on the deeper layer, SC4 believes that the mussel larvae favour high salinity conditions. The two catching methods outlined below are based on their descriptions and reflect their understanding that green mussel larvae thrive at the deeper layer.

Spat catchers utilised two different methods to catch green mussel spat; shallow spat catching and deep spat catching. Shallow spat catching involves putting spat catching gear in the shallow layer at the head of a bay. When a strong wind blows from the land to the sea, the surface current moves the shallow layer towards the sea and the water from the deeper layer moves upwards at the water near the head of the bay. The upwards movement of the deeper layer causes the “upwelling of green mussel larvae to the shallow layer” which settles onto the spat catching ropes on the shallow layer (SC4). SC3 added that “ twenty years ago, spat catchers would rush to shallow spat catching sites and set up the spat catching gears just before or beginning of strong southerlies. If the green mussel larvae are present in the deep layer, over the two days of strong southerlies, the spat concentrated at the head of the bay in the deeper layer would move upwards by the movement of the water and get caught on the spat catching line at the shallow layer.” As a result, shallow spat catching was heavily dependent on the direction of the wind, the geography of the bay and the presence of green mussel larvae in the bay (SC3) demonstrated by figure 5.13. SC3 and SC4 stated that Crail Bay was a good shallow site.

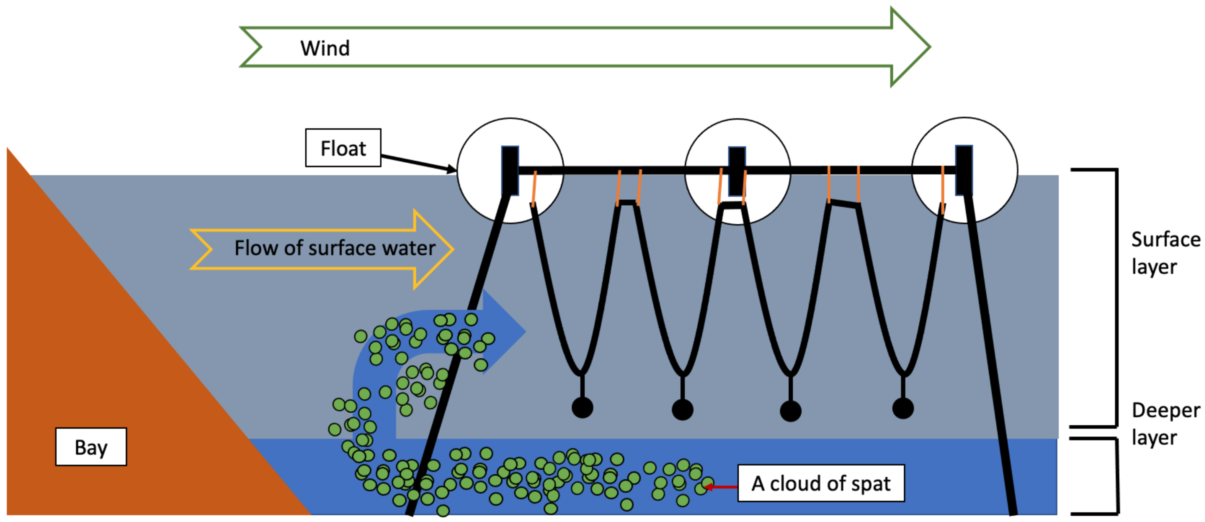


Figure 5.13 The shallow spat catching method.

Deep spat catching refers to spat catching by sinking a backbone longline to 10 metres below the surface of the water and hanging spat catching ropes (droppers) on the longline directly into the deeper layer (figure 5.14). SC3 noted that the “deep spat catching operation is a more difficult operation compared to shallow spat catching especially when windy. These deep sites were discovered in the 1980s. SC3 mentioned that “Clova Bay was a good deep spat catching site (figure 5.15).”

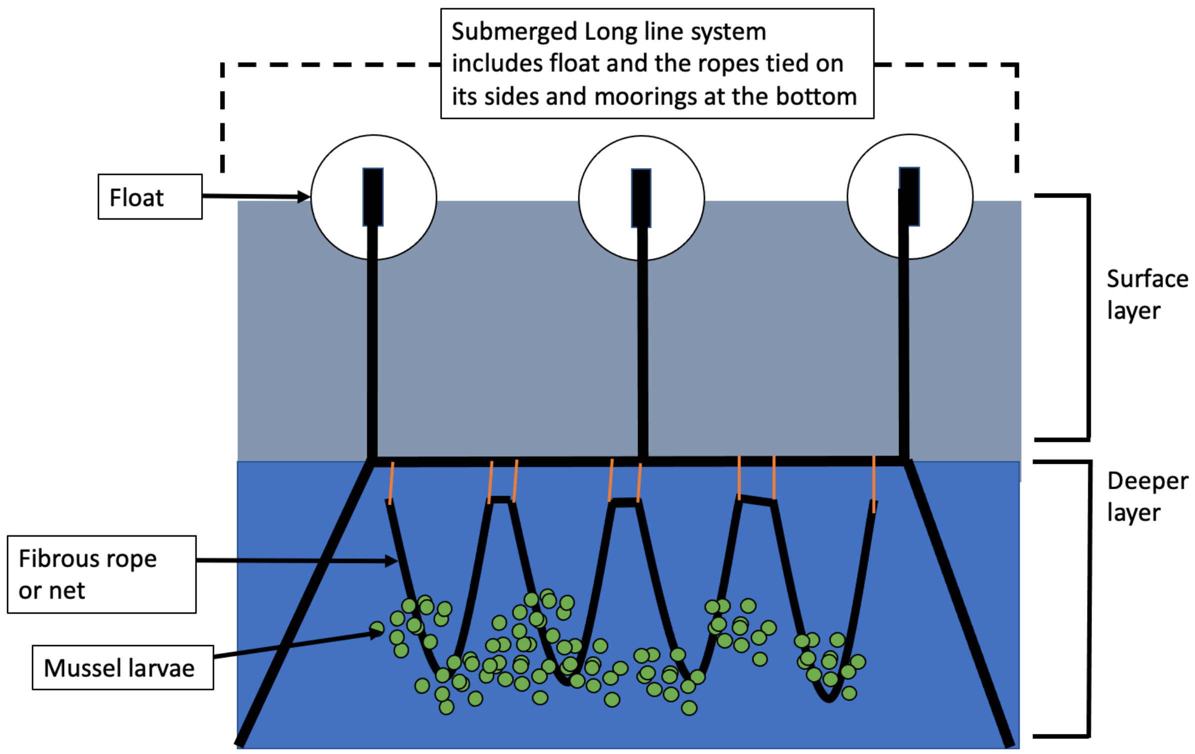


Figure 5.14 The diagram on the configuration of longline system and the equipment for deep spat catching.

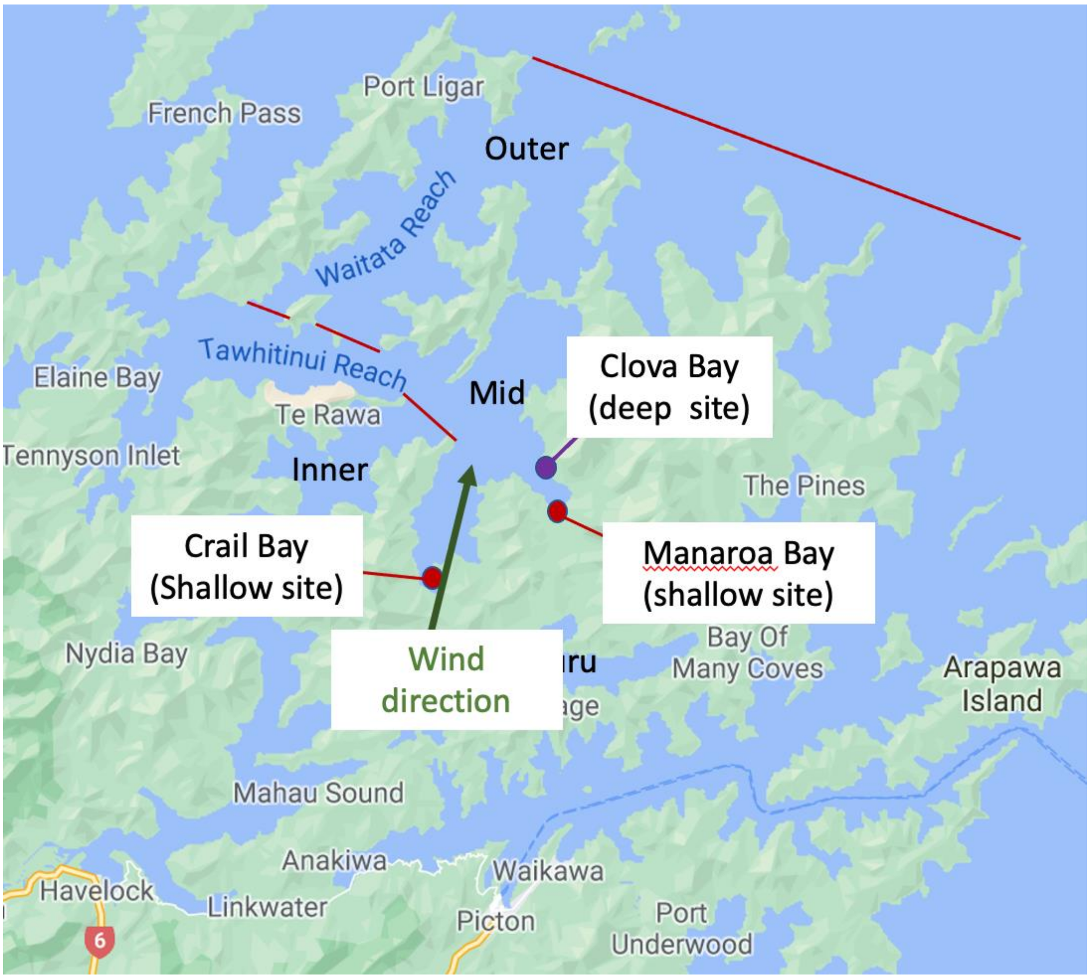


Figure 5.15 Map of Pelorus Sound showing Crail Bay, Clova Bay and Manaroa Bay

SC3 asserted that the ideal conditions for deep spat catching are “two weeks of calm and windless weather.” SC3 theorised that very rough winds mix the water layers which reduces the spat settling onto the rope. This was based on his experiences with cyclone Bola at Manaroa Bay (figure 5.15). Cyclone Bola caused “massive Southerlies for four days”. Before the storm hit, he had good spat settlement onto the rope. Based on his previous experiences, the four days of wind should have brought green mussel spats onto the shallow layer. However, the rope that he set up after four days of wind did not have mussel spat on the rope. Therefore, SC3 theorised that “Bola was so vicious and turbulent that it mixed the water and killed or inhibited spat settlement behaviour.”

Unlike Pelorus Sound, Wainui Bay is a shallow site where the depth of the water column is only 6 meters. SC5 stated that his crews have tried various methods. Initially, SC5 stated that they had used continuous rope loops on a longline backbone and then decided to use frames. The frames containing spat catching ropes were hung from the longline. The Frame method did not significantly improve spat catching. Furthermore, frames were more inefficient than ropes because transferring the frames from sea to land was highly labour intensive. Thus SC5 changed back to using continuous ropes on a longline backbone. SC5 observed that even in Wainui Bay, more mussel spat are caught at the deeper level.

It was clear that the spat catching was a seasonal activity however there were some differences. In Pelorus Sound, SC3 stated that “spat catching was better in Autumn.” More recently, SC3 experienced “good spat catching in November before Christmas.” On the other hand, SC4 informed that he usually targeted for “the end of January to mid-April.” Differences in the season could be due to different spat catching methods. In Wainui Bay, SC5 stated that spat catching occurs during the winter times. S10 recalled that twenty years ago, spat catching in Wainui Bay occurred during the warmest month. It seems that both Pelorus Sound and Wainui Bay are experiencing shifts of spat catching seasons.

5.5.2 Spat holding

After the green mussel spat have grown to 1 mm, the spat caught on the ropes, they are shifted to different areas. Spat catchers from both Pelorus Sound and Wainui Bay hold spat at more than one different location.

In Pelorus Sound, SC3 said that the spat holding stage lasts 20 weeks. SC3 emphasised that the spat holding stage is a “very delicate stage” because “a lot of failure or spat mortality occurs at this stage.” SC3 had been doing spat holding at the outer Pelorus Sound because by trial and error, outer Pelorus Sound worked better compared to other locations. SC3 added that “outer sounds for the last twenty years had been successful at keeping the spats alive than the inner sounds where the spats are caught”. SC3 emphasised that the location of SC3’s holding areas did not have rough waters and areas with less blue mussels to prevent biofouling. However, SC3 didn’t know why spat survived better in the outer sound. On the other hand, SC5 stated that he and his crew “hold the spat in areas like Golden Bay.” SC5 also assumed that the holding sites have “more food or the right sort of food.”

5.5.3 Reseeding from intermediate and later to the final crop

The reseeded ropes are wrapped with cotton stocking (photo 5.3). All spat catchers used the cotton stockings to enable the spat to reattach onto the rope. The cotton stocking slowly breaks down and completely disappears which can take two to three weeks in Winter and three to four weeks in Summer (SC3). SC3 said that there are variables in the cotton in terms of thickness, number of stitches and tension. SC3 used Coromandel mussel spat catching as an example of using very thick cotton stockings to prevent predation by fish. In Pelorus Sound, they use thin cotton stockings because the predation of spat is low.

Photo 5.3 The mussel stocking

The process of reseeding usually occurs twice. The product from first reseeding is usually referred to as the intermediate. The intermediates are reseeded again to reduce the density of spat per meter of rope to give a crop of mussels. The crop is grown and fattened to give a final product through filter feeding on nutrients in the water column, of green lipped mussels. SC3 said that the reseeding of both spat holding rope and intermediates are wrapped with mussel stocking to enable the spat to reattach onto the rope. On the other hand, SC4 does not make intermediates. SC4 holds the spat for a “minimum of 6 months and maximum of 18 months before seeding the mussel spat for crop.” Retaining spat is difficult after reseeding. The reseeding process can be seen as stripping spat from the initial settling surface (e.g., the rope) forcefully by “tearing” the byssus thread. Therefore, the spat need to produce byssus thread again to reattach to a new surface. The byssus production is metabolically expensive for juvenile spat thus S2 argues that spat that are well-fed will retain better, hence the importance of a good holding site.

5.6 Interaction with other organisms

Section 5.6 and 5.7 aim to answer the biophysical factors that are related to spat catching operation. No spat catchers seasoned ropes with seawater to develop bacterial biofilms to assist the primary settlement of green mussel spat. In fact, all spat catchers stated that the ropes should be clean and free of any chemicals or organisms before being used. Notably, SC5 showed that his crews wash the ropes using seawater and stated that” There should be no additives or chemicals added onto the rope”. SC5 further stated that “it (rope) should not have any slimy stuff on it”. S6 concurred and even stated that “thicker biofilms do not allow spat to adhere well to the surfaces.”

All spat catchers stated that M. galloprovincialis (blue mussels) is the key biofouling specie and makes the production of mussel spat inefficient. All spat catchers monitor the number of blue and green mussels spat count. In Pelorus Sound, SC3 and SC4 both stated that it is becoming more and more difficult to find opportunities to spat catch without blue mussels. SC3 even observed that the blue mussels encrust the green mussels and described the blue mussels as “hungrier” mussels. The blue mussels were always present in Pelorus Sound, but Wainui Bay and Golden Bay spat catching sites only recently were infested with blue mussel settlement. SC5 stated that he wasn't sure "how the blues got into Wainui Bay" As they were not originally in either Golden Bay or Wainui Bay.

However, while SC3 recalled that there were a few unsuccessful attempts at developing blue mussels as an economically viable product due to pea crabs, SC4 disagreed with the reason, observing that the blue mussels in Pelorus Sound do not have pea crabs. SC5 added that due to low meat and the likelihood of pea crabs in the meat, the price of blue mussels would be significantly lower than that of green mussels which may not be financially efficient. Furthermore, blue mussels are more difficult to process due to weak byssus threads and fragile shells. Therefore, the blue mussels do not bind to ropes strongly and can shatter easily during reseeding procedures.

All spat catchers concurred that predation is not a problem in both Pelorus Sound and Wainui Bay. SC4 stated that "not much of it (predation) happens" in Pelorus Sound and SC3 concurred. On the other hand, S6 made a contrasting statement that the predation is likely to be significant because stocks of snapper have increased in the Tasman region. S6 argued that snappers do predate on green mussel spat. S6 referred to the Tasman region which would involve Wainui Bay. However, even SC5 did not identify that predation was a major problem. Therefore, it could be seen that the predation of green mussel spat occur in Wainui Bay but not to a point of financially significant level.

5.7 Environmental factors that impact on spat catching

There are a number of places above where the author has reported observation on environmental variables. In this section, the focus is more specifically on biophysical environmental factors.

SC4 that "there seems to be a correlation between high water flow and successfulness of catching spat." S2 also viewed water flow as important, but for secondary settlement, arguing there are no indications that high water flow is important for primary settlement. However, S2 conjectured that with high water flow, more larvae are available to flow past the rope which increases the chance for larvae to settle onto the rope.

Oxygenation and highly turbulent environments could induce better green mussel spat retention and settlement. S6 described his experiences with a spat catcher who put a lot of floats on the spat ropes to give vertical movement to the rope whenever a wave passed over the longline structure. S6 conjectured that vertical movement of the rope removes sediments and facilitates high oxygenation and delivery of food to the spat seeded onto the line. Therefore, wave action may be important for retaining spat after reseeding. Consequently, S6 believes that outer Pelorus Sound is more successful at spat catching due to the high frequency of wave action and wind compared to inner Pelorus Sound. Similarly, S4 stated turbulent waters provide a highly oxygenated environment and such an environment increases the ability for spat to settle. S4 added that farms with turbulent and dynamic environment showed better spat settlement. However, S3 argued that the Pelorus Sound contains sufficient levels of oxygen thus it would not be a significant factor.

S1 emphasised that El niño and La niña cycles were important ecological systems for Pelorus Sound, stating that El niño is particularly important because the Northwesterlies generated by El niño driving onto reef systems in Kahurangi shores induces upwelling of nutrients which are taken up by the plankton and driven into the Pelorus Sound by the wind. At the same time, Northwestlies generate rainfalls in the headwaters of the catchment of the Pelorus River that drives the organic matters and nutrients from the land into the Pelorus Sound. As a result, there is “increased marine productivity.” Due to the increase in productivity, S1 conjectured that there would not be spat settlement problems during El niño conditions. On the other land, La niña is a reverse of El niño. The wind originates from the North North East. Unlike El niño, La niña does not generate the “massive pulse” of nutrients and plankton (S1).

Pelorus Sound spat catchers, SC3 and SC4 were unsure about the El niño and La niña cycle on the green mussel spat. SC4 observed blue mussels spats were more dependent on the El niño and La niña cycle. It is interesting that SC3 had drawn attention to the Southerly wind on shallow spat catching but did not link El niño and La niña cycle with the wind direction (section 5.5.1). SC3 had drawn attention to the Southerlies on shallow spat catching On the other hand, SC5, operating in the shallower Wainui Bay, argued that the El niño and La niña cycle is an important factor because the weather generated by the cycle is ideal for catching spat. SC5 described the ideal weather generated by the cycle as occurring from September, December and to January. “North Westerlies that start from spring, they [the wind start at 9 to 10 o’clock. The North Westerly blows like hell all day and then … it [the north westerly] is flat at night.” SC5 added that such weather is very difficult to work in but lately the ideal weather condition by this cycle doesn’t occur easily.

In Pelorus Sound, the fine sedimentation run off occurs due to unsustainable land use such as deforestation (S1). S10 described that deforestation leads to massive erosion which causes a huge amount of silt and soil to enter into the Sound. Both S6 and S10 theorised that the fine sediments could impact the phytoplankton level that the mussel spats eat. Fine sediments can bind with nutrients in water like phosphate which reduces the nutrient level for phytoplankton. Additionally, the fine sediments can also shade the phytoplankton which reduces the photoperiod. Both elements can reduce phytoplankton production. Furthermore, both scientists conjectured that the feeding efficiency of mussel spat would be reduced because the spat need to filter out the sediments to ingest the phytoplankton.

On the other hand, S2 disagreed that sedimentation has an impact on spat catching. S2 argued that the population of larvae available is extremely low thus commercially not viable. He said, “there aren't many [green spat] left." S3 remained neutral and stated that there was currently no evidence that the sedimentation run off from forestry businesses have an impact on spat catching or the population of larvae available.

In response to the author raising these issues with the spat catchers only SC4 had any comment. He asserted that "there seems to be some correlation between harvest of pine trees and failure of spat catching." He observed that once the pine trees are harvested, the land is left bare for six months. All the seeds germinate and the pine industry spray the seedlings with Roundup (a glyphosate-based commercial spray in common use in New Zealand, but banned in Austria (Peng, Lam, & Sonne, 2020). SC4 stated that he would like to know whether there is a correlation between green mussel larvae in the water and the Roundup runoff.

5.8 Summary

The spat catching methods used by the three spat catchers interviewed, differed, and there are some clear difference between the spat catching sites and changes are occurring within them.

The spat catching sites in Pelorus Sound were found by luck and constant monitoring that identified ideal seasons for spat catching. However, it currently is very unreliable and "doesn't work" due to low green mussel spat compared to blue mussels. On the other hand, Wainui Bay still has successful spat catching operations but is less successful compared to the past most likely due to the introduction of blue mussel to Tasman areas.

The spat catching technology is highly dependent on the use of fibrous materials and weight. The spat catchers who utilise plastic mesh net and unleaded ropes require concrete weights, but this is known to be labour intensive. It is important to note that all the spat catching ropes and nets simulate thin filaments to provide settlement surfaces.

The MFA spatfall monitoring programme is used by all spat catchers, but this may be augmented by individual monitoring and instinct. The spat and settled spat are not observable for four weeks due to their microscopic size, thus spat catchers have used the weekly monitoring program to understand the seasonal trends and windows of opportunity to start spat catching in certain locations.

The most notable biofouling specie in the context of spat catching is blue mussel spat. The blue mussels are a low value specie because it can have pea crabs and have more fragile shells that can be crushed easily during the reseeding processes.

Some of the knowledge held by spat catchers in relation to environmental elements related to hydrologic factors such as water layering, water flow wind, oxygenation and sedimentation.

Spat catcher SC4 has observed that the faster water flow facilitates spat catching which is in accord with the general view of the scientists who agreed that highly oxygenated and turbulent areas are best for spat retention after the seeding phase. However, SC3 observed that all of the spat holding sites that he uses have calm waters with less blue mussel infestation. The spat catchers from Pelorus Sound have observed that the El niño and La niña cycle does not contribute to the success of green mussel spat catching. On the other hand, the Wainui Bay spat catcher stated that the weather generated by the El niño and La niña cycle is the key to spat catching.

Lastly, there is a conflict between scientists on the impact of sedimentation on the spat. Some scientists believe that sedimentation can impact the food supply of spat which in turn reduces the quality of the area that will generate secondary settlement behaviour and increase the mortality of spat. SC4 observe that the failure of spat catching with the pine industry practices their use of Roundups.

Chapter 6

Findings on Community interaction

This chapter outlines the findings on the community interaction that enable us to understand the social landscape that spat catchers face. The chapter initially discusses results in relation to the concept of a social licence to operate, this is followed by a discussion of other aspects of the spat catchers' relationships with the community and finally, the results of the planners' views on the value of the inclusion of spat catcher LEK in the planning process.

6.1 Relationship with the community

Beach clean-up organised by MFA was seen positively by all the spat catchers. SC3, SC4 and SC5 stated that beach clean-up occurs twice annually and is necessary. SC3 further explained that most of the waste comes from 3 ply lashing that attaches the mussel ropes (figure 6.1). SC3 described that up to three hundred lashings are used when harvesting a line of mussels. Lashings are cut off during mussel harvesting. SC3 believes that around 1 to 0.5 percent of the lashings would not be appropriately collected and float onto the beach. SC3 gave an example. "Lashings are cut off during the mussel harvesting, and sometimes lashings knotted on the backbone longline are potentially loose and later float away." SC3 believes that the clean-up is effective and obligatory, and the mussel industry is highly aware of lashing problems.

Figure 6.1 The black lashings used to tie the spat rope or net onto the longline structure.

Interestingly, SC5 stated that all the industries adopt specific beaches. Four different companies also have “hotspot rosters”. The company that employs SC5 cleans up particular beaches in Pelorus Sound where the wind “funnels stuff into these beaches.” SC5 stated the company cleans the beaches every quarter.

SC5 also described a mentor employed by MFA to check the aquaculture practices, including assessing nets, scoops, and rubbish bin setups. The mentor “travels around with a boat and can board the ship to talk and assess the crews.”

The local community in Wainui Bay are affected by the noise and lights. P6 commented that the community was less tolerant of the site and that was “an issue that came up in hearing when renewing the consent.” Noises from the spat catching operation were one of the significant issues in Wainui Bay.

The Wainui Bay spat catchers need to comply with noise level conditions in the coastal permit. The noise from spat catching operation cannot exceed 50 dBA 10 percent of the time. During the night, the noise can exceed 40 dBA 10 percent of the time. The possible maximum noise level for both day and night is 70 dBA. Therefore, most noises need to be below 50 dBA during the day and 40dBA during the night. Furthermore, the spat catching vessels “cannot broadcast radio station, digital, analogue recorded noises” at night except Marine radio, which is necessary for the vessels.[56]

SC5 stated that “It is not as bad it used to be.” SC5 stated that the company he was working in complied well to reduce noise. In late 2017, a boat from the company was in service for two years in Wainui Bay. However, it proved too noisy and a few people commented on it. The company paid $20,000 and “added muffler engine which reduced the noises of the boat even further.” MFA has developed a “code of practice” that “avoid, remedy or mitigate non-operational and unnecessary noises from working vessels in Wainui Bay.” The practice code includes maintaining minimum noises at night and radio usage and restricting vessel speed to 5 knots. The code of practice is formatted into a poster and attached to the vessels as a reminder (figure 6.2).

[56] Tasman District Council, s 42A report for Plan Change 61 in Appendix F.

Figure 6.2 The sticker form of Wainui Bay Code of practice in poster.

Wainui Bay spat catching operation requires lights to ensure safety and practical reasons, especially during winter. Light shining from workboats during the night had previously caused problems with residents. The Wainui Bay crew had improved the procedure by minimising light shone on the land and ensuring that the working hours are between 6 am and 8 pm. The code of practice by MFA concurs that Wainui vessels need to turn off spotlights once the spat catching “lines are located, and the vessel is secured.” Only “working” deck lights can be used if necessary, to minimise lights spill.

The vessels in Wainui Bay can operate from 6 am to 8 pm, known as “operating hours,” and during the winter, SC5 and his crew can only operate during the daylight. The operation can occur outside of operating hours five times annually when exceptional circumstances occur.[57] Rountree gave an example where the spats need to be harvested quickly before a storm arrives at Wainui Bay. Each operation outside the operating hours needs to be reported to Council within 24 hours before the operation begins (TDC, 2016). Some submitters had concerns on the operating hours, and evidence from an applicant stated that these working hours are necessary to ensure flexibility at the farm.[57]

P6 stated that a liaison meeting was previously held every year where “representatives of marine farmers, community board members and council members” met together to resolve any matters that concern the residents. In 2013, the residents observed less rubbish, and in the 2014 meeting, the residents recognised that the operational processes were much improved and had no complaints. In the 201 meeting, only one person had a complaint.[58]

In Pelorus Sound, the coastal permit does not have stringent rules on noise but needs to follow the lighting plan for navigational safety.[59] SC3 stated that noise is not a concern in Marlborough Sound, but there is a massive focus on the amenity and visual aspect. Many residents felt that the longline backbone structure “ruins the view” (SC3). SC4 did not recall any community interaction except during the submission phases for a coastal replacement permit.

The community of spat catcher is divided into corporate and family businesses. All the spat catchers have concurred that the corporates do not interact with smaller family business orientated spat catchers. The company in Wainui Bay also have farms in Pelorus Sound but do not synergise with small spat catchers because the spat catching in Pelorus Sound is “dead” (P5). According to SC3 and SC4, the family business orientated spat catchers are now “unique” but occasionally have conversations with family business spat catchers with another small family business spat catchers.

[57] Evidence of Matthew James Rountree in at [21-22]
[58] Evidence of Matthew James Rountree at [20]
[59] Outlined in decision report on Clova Bay spat catching site.

6.2 Feedback from planners on the LEK

As noted in the methodology chapter, two conceptual input-output diagrams were developed; one for Pelorus Sound and the other for Wainui Bay (Appendix D). This included the knowledge added by the spat catchers, planners and scientists. The diagrams were provided to the planners as part of gaining feedback on the value of including spat catcher LEK in planning processes. The feedback included comments on the value of the diagram itself.

P1, P2, P3, P6 and P7 have collectively commented that the conceptual map is useful for educating planners who are either new or inexperienced in marine aquaculture resource consent applications. P7 found that colour coding processes helped direct attention to specific elements. Therefore, it is easy to follow through complex information. P1 added that the conceptual diagram reinforces what is already known to the planners familiar with the fishery and aquaculture. There is a value for consent planners to know that structures and mitigation procedures are developed to enable social license (P3).

LEK on the conceptual diagram also provided a reality check on factors that need to be considered from an operative perspective that some policy planners and resource consent decision-makers overlooked. P7 commented that it could facilitate consensus building because this LEK can only be acquired by communicating with the marine farmers and how the overall mussel industry understands the resource consent processes. On the other hand, P3 identified that policy planners are restricted to green boxes (the regulatory factors in both diagrams in figure 7.1 and 7.2) to understand the activity and its effects. The resource consent and industry planners could use the conceptual diagram to understand spat catching activity details.

As a limitation, the conceptual diagram did not provide possible environmental impacts generated by spat catching. P2 stated that the model outlines the processes but not the environmental impacts of the activity. P3 concurred and further stated that most of the information on the conceptual model is "beyond our sphere." Consequently, the conceptual model will have less impact on the planning process because planners will heavily focus resource consents on the specifics of the structures and conditions within rules and coastal permit.

P7 suggested that iwi and cultural components should be added to realise the cultural landscapes. Furthermore, she suggested that landscape and natural character and biosecurity elements should be incorporated because "it is statutory."

The conceptual model presented presents a typical spat catching process that may not be true for some other geographical locations. P1 commented that the conceptual model fundamentally assumes that spat catching will be similar. P1 argued that the assumption is likely to be incorrect because there are uncontrollable variables and changes in the process that might occur to adapt in a precautionary manner.

6.3 Finding Summary

Beach clean-ups, operational programmes by MFA and Aquaculture NZ, measures to avoid ort mitigate adverse environmental effects and annual meetings with the community appear to support and maintain a positive relationship between the industry and the local community, necessary to obtain and retain the social licence to operate. Additionally, the finding included the interaction with the residential community and spat catching community.

The feedback on the conceptual diagram revealed that there were advantages and limitations. All the planners agreed that the conceptual diagram is useful in educating planners who are inexperienced in aquaculture resource consent. It provides essential factors for spat catching operation that resource planner may have overlooked, but it lacks attention to environmental impacts that might be caused by spat catching activities and omitted some features required by law to be considered by planners

Chapter 7

Discussion

The aim of this research is to uncover the extent of LEK can facilitate the planners to understand the dynamics of the socio-ecological environment of green mussel spat catching. The following chapter has four themes; LEK within the legislative and regulatory environment; Impact of community interaction on LEK and the biophysical factors that are related to LEK; technology that shaped LEK. Lastly, the conceptual input-output diagrams were discussed.

7.1 LEK within the legislative and regulatory environment

This section discusses the legislation, policy, rules resource consents and other regulatory mechanisms that may have significant effects on spat catching operation and the way that spat catching have adapted to regulatory environment. The spat catchers are highly aware of changes in regional plans and the costs involved. This is exemplified by SC5 who had correctly identified that Wainui Bay was not an AMA and understood differences between controlled activity and discretionary activity. SC5 was well aware that controlled activity would have secured subsequent replacement coastal permit. In the Pelorus Sound context, SC3 and SC4 were aware that the aquaculture chapter was missing in the Proposed Marlborough Sound Environment Plan (PMEP) and was operating within Marlborough Sound Resource Management Plan (MSRMP). SC3 added that the benthic survey required for assessing the effects of marine farms is expensive and that RMA had brought too many procedures, leading to costs. On the other hand, SC4 stated that he agreed that RMA had become too complicated but did not have problems with procedures.

It was identified that within Pelorus Sound and Wainui Bay, it is unlikely to have a coastal permit for new spat catching sites in a new coastal space. Therefore RMA-FA coastal permit pathway in appendix E may not be as relevant for these two areas. On the other hand, replacement coastal permit regulation is more important for spat catching sites and is not subjected to aquaculture decision by FA. This is assuming that the spat catching sites do not change the location or change the catchable species.

Pelorus Sound spat catching sites are likely to maintain controlled activity status under replacement coastal permit pathway under MSRMP. The controlled activity status will be retained only if the spat catching site do not have any changes to the longline structures and the list of catchable species (P2). As a result, spat catching technology will unlikely to move beyond the longline system to continue to gain resource consent under specific conditions. It is highly likely that innovations may occur in the configuration or materials of spat catching ropes. or nets that are attached to the longline system.

NZCPS 2010 is the most important coastal policy document because it now sets the amenity, natural character, obligatory. NZCPS was released later than MSRMP and TRMP therefore, both Marlborough Sound council and Tasman District Council will need to give effect to the NZCPS. Both Tasman District Council and Marlborough Sound District Council contained policies and rules aligned to NZCPS hence there will be no radical changes in planning practices. Therefore if there are any new spat catching sites, it needs to consider the amenity and natural character of landscape and seascape.

7.2 Impact of community interaction on LEK

This section discusses the community interactions that may had changed the spat catching LEK. LEK is likely to include the social license to operate (SLO) to retain replacement coastal permit for spat catching due to NZCPS 2010. The NZCPS is the most important in terms of the social environment because it now makes the amenity, natural character, to be seen as more obligatory under RMA. NES For MA 2020 is too flexible, and the council are not required to use the NES for MA 2020. No literature has explored the spat catching or aquaculture LEK within the social environment.

The definition of SLO in New Zealand aquaculture is not consistent across documents (Newton, Farrelly and Sinner, 2020). Baines and Edwards (2018) suggested that openness for communication and building trust are needed to achieve establish a positive relationship for SLO. In the context of Wainui Bay, communication and trust arise from consistently complying with the code of practice, liaison meetings and staff for contact.[57, 58] The Wainui Bay residents accepted the spat catching operation because the feedbacks from the residents were met and improved the amenity values. However, the interactions had not gone beyond liaison meetings to achieve consensus through communicative rationality because there is no mutual understanding emerging from the residents and the spat catchers (Healey, 1992; McGuirk, 2000).

On the other hand, the spat catchers in Pelorus Sound may not achieve the level of SLO as in Wainui Bay because many farms within MSRMP have controlled activity status and attempts to build social capital through the annual beach clean-up. There are no formal or informal meetings aiming to develop consensus with the residents and the spat catchers. As a result, residents may attempt to bring more conditions to the controlled activity status to resolve their issues on the visual degradation caused by spat-catching sites but not as sensitive as in Wainui Bay (Banta, Gibbs 2009). The commissioner and planner resolve the issue between the spat catcher and the local residents by logical reasoning and weighing the options using local plans, NZCPS 2010 and RMA. Therefore, there is no communication beyond formal hearing and consultation, which may lead to negative relationships, lack of consensus and perhaps misunderstanding between residents and marine farmers. It implies that RMA and the hearing procedures do not facilitate nor build SLO (Quigley & Baines, 2014).

The beach clean-up is being utilised as an (SLO) and is used by the entire mussel industry to gain social capital with the public and with the planners. All spat catchers do beach clean-ups twice annually, and some major corporates are included in hot rosters to remove any remaining aquacultural wastes. SC3 viewed beach clean-up as a way to remove any loose black plies and floats that were lost, which minimises the impacts of spat catching sites and other marine farming activities on the coastal environment. Therefore, the spat catchers who are not part of the corporates, do not engage with the local residents under the assumption that beach clean up is already a significant way to generate social capital with the local community (Baines & Edwards 2018).

7.3 Biophysical factors that are related to spat catching.

This section discusses the various biophysical factors that are related to spat catching operation which include water movement, biofouling, predation, El niño and La niña cycle that impact annual spatfall patterns in the spat catching sites. The importance of water current direction varied with the location. In Wainui Bay, the SC5 regarded the eddying current developed by rocks on the Northern part of the farm was crucial. SC5 and S10 both believe that the eddying current accumulated the green spats within the Wainui Bay and exposed the spats to the rope multiple times. Currently, there are no academic studies that have examined the eddying water current of Wainui Bay. In Pelorus Sound, the shallow spat catching was dependent on the localised upwelling created by the wind-induced water current. However, It was unexpected that the orientation of the spat catching rope was important in deep Spat catching. The author assumed that the orientation of the marine farm maybe crucial as spat larvae drifts in the water column by a specific direction of water current. S6 explained that it is impossible to recognise the current water direction that carries the cloud of spats because the mussel larvae are microscopic in size, thus impossible to observe with naked eyes (SC6). Spat can only be observed after the spat has settled for four weeks. As a result, qualitative LEK is limited because mussel settlement can only be observed after four weeks of retaining spat catching rope on the spat catching site.

It was unexpected that the annual patterns of spat catching sites could be disrupted and no longer work in Pelorus Sound. SC5 even called Pelorus Sound to be “dead”. The sites were identified by luck (SC3), and the patterns were identified through the spatfall monitoring programme. It suggests that the LEK of spat catchers were not adaptable due to lack of variables and perhaps complacency and notion that the spat catching site will not perish. It is possible that LEK to identify new suitable spat catching site could not be developed due to the microscopic size of mussel larvae and complexity of the water column in Pelorus Sound (S1).

The El niño and La niña effects on spat catching had different perspectives. Pelorus Sound spat catchers, SC3 and SC4 were unsure about the El niño, and la niña cycle on the green mussel spat. Both spat catchers did not link the wind direction that could be dictated by the El niño and La niña. Wainui spat catcher, SC5 has argued that the weather generated by El niño is important for spat catching. This could be due to geography differences in Pelorus Sound and Wainui Bay. A predictive model of spat settlement developed with the spatfall monitoring in Pelorus Sound and Wainui Bay, included Southern Oscillation Index (SOI) that indicate El niño and La niña (Atalah & Forrest, 2019). Indeed, the SOI had the second highest influences to the model. The Wainui Bay had influenced 17.17 percent and Clova Bay in Pelorus Sound influenced 8.94 percent to the predictive model (Atalah & Forrest, 2019). This reveals that El niño and La niña had a more pronounced impact on the Wainui Bay compared to Pelorus Sound. It is highly likely that the spat catchers in Pelorus Sound did not detect or link the El niño and La niña due to relatively small significance compared to Wainui Bay. The predictive model Atalah & Forrest (2019) also indicates that LEK of spat catchers can overlap and is highly likely to integrate sciences to validate their experiences and increase their successfulness in spat catching. However, this predictive model may not be suitable for spat catchers because the model has not accounted for shallow and deep spat catching method. The predictive model would have been more useful for spat catchers if it had two different models that shows green mussel settlement in shallow layer and deep layer.

The most notable biofouling specie was the blue mussels. The blue mussels in both Pelorus Sound and Wainui Bay. The opportunity to catch only pure green mussel spat is now impossible for both Pelorus Sound and Wainui Bay. Now the minimum ratio of green mussel to blue mussel is 7 to 3. SC4 believed that el niño and la niña cycle had an impact on the blue mussel and this was also shown by Atalah, Rabel & Forrest (2017) using the Southern Oscillation Index.

The impact of the pine industry in Pelorus Sound was seen as significant by SC4. SC4 asserted that the harvest of pine trees which includes sedimentation problems and Roundup runoff could be correlated to spat catching failure. The Roundup runoff hasn’t been investigated, and there are conflicting arguments within scientists on the sedimentation runoff caused by forestry businesses. S2 disagreed that the sedimentation has an impact and argued that the population of green mussel larvae is extremely low. S1, S6 and S10 argued that the sediments are likely to be a factor that reduces the feeding efficiency of mussel spats and phytoplankton level. This implies that sedimentation level and phytoplankton levels need to be assessed to improve the understanding of mussel larvae within the context of Pelorus Sound.

There was some contradiction between scientists and spat catchers on the effect of turbulent water. S6 gave an example of an LEK of a spat catcher who used more buoys on the longline system in outer Pelorus Sound. The waves frequently passing the longline gave continuous vertical movements which lead to more oxygenation, fewer sediments on the spats. S4 added that farms with turbulent and dynamic environment showed better spat settlement. The body of literature show that turbulence of water could improve the retention in secondary settlement (Alfaro, 2005, 2006). This contradicted with SC3 who stated that calm waters are required to hold spats.

Predation was not observed to impact both Wainui Bay and Pelorus Sound, which were contradictory. All spat catchers concurred that predation is not a problem in both Pelorus Sound and in Wainui Bay. SC4 stated that "not much of it (predation) happens". This contrasted with S6, who stated that the stocks of snapper have increased in the Tasman region which would predate upon the spat. This indicates that Wainui Bay may encounter predation problems in the future as it is part of the Tasman region. Jenkins (1979) stated that there were predation problems by snapper in the past in Pelorus Sound, but the book does not clearly outline whether the predation also happened at the spat catching level.

The impact of water flow speed on spat catching was inconclusive from the LEK standpoint. A body of literature suggested that fast water flow was required for all both primary and secondary settlers (Alfaro, 2005, 2006; Sanjayasari & Jeffs, 2019). Spat catchers were unsure because these were not measured. SC3 did not observe any noticeable differences in the water speed relative to each layer.

7.4 Technology that shaped LEK on spat catching

This section discussed the changes in the technology within the socio-ecological environment. All the spat catching ropes or nets were characterised by thin filaments which imitated the finely branched macroalgae (Buchanan & Babcock, 1987). SC3 and SC6 both had used vocabulary such as "cloud of microscopic larvae" which indicates that the spat catching equipment target to catch primary settlers. SC4 an SC5 preferred certain types of spat catching rope because of the filament characteristics.

The method of spat catching was determined by geographic locations. For example, Pelorus Sound had two methods called shallow and deep spat catching because there were two layers of water and was assumed that the green mussel spats thrive in the deeper layer. On the other hand, Wainui Bay only had spat catching similar to shallow spat catching because the water level is shallow.

LEK of spat catchers are not based on cultural nor spiritual beliefs. The efficiency of spat catching ropes was tested similar to a scientific method. SC3 used the rope as a control to see the relative spat settlement on the net to understand and accept that using the net was more profitable. LEK can be characterised as practical knowledge within specific spat catching sites using quantitative sampling of spatfall monitoring. There was no LEK literature that has outlined quantitative monitoring which reveals that spat catching LEK in New Zealand is unique. It is likely that the spat catchers may adapt to co-creating knowledge with scientists easier if spatfall monitoring is used as the foundation for analysis.

Additionally, the theories developed by spat catchers are supplemented by experiences. Qualitative LEK such as the account of cyclone Bola with SC3 also involved comparing the windless day and windy days (section 4.5.1). The anecdotes were used to develop theories to aid spat catching. Therefore spat catching LEK can be characterised as a set of practical knowledge applied to spat catching areas. Accordingly, the spat catchers likely to change or become more innovative if the scientists can provide various theories that can aid spat catching. The theories developed by qualitative LEK can be traced back to the observations to create hypotheses. Consequently, the co-creation of knowledge by local scientists and spat catchers can have collaborative nature where the shared knowledge reflect economic success and scientific validity.

Furthermore, the planners could discuss with the scientists, spat catchers, marine farmers and relevant landowners to understand the specific and cumulative effects of the activities in coastal space. The cumulative impacts and effects of marine farms to innovate water space allocation and marine farm development. Ultimately, the shared knowledge would expand to understand the spatio-temporal patterns of mussel larvae and the interaction with different biofouling species across the entire Pelorus Sound.

Planners and scientists should not have unrealistic expectations from the LEK. The feedback for the conceptual diagram revealed that the current resource consent planners and policy planner have an understanding of spat catching operation but wanted to understand the environmental effects generated by spat structures. The only environmental impacts that are considered by the mussel industry are the ply lashings and floats that get lost to the sea in section 5.1. The spat catcher's LEK is currently defined by the spatfall monitoring programme by MFA and experiences of success and failure. It is unrealistic for planners and scientists to ask spat catchers on the impact of spat catching structures because spat catchers may not monitor the benthic floor regularly and the tools of interest have been the spat catching ropes. The spat catcher LEK is heavily focused on obtaining spat thus they only have superficial environmental impacts on species that are not relevant to mussel spat catching or mussel farming. Ruddle and Davis (2011) observed that the LEK in local fishermen in Vietnam did not identify species that are not identifiable for commercial use.

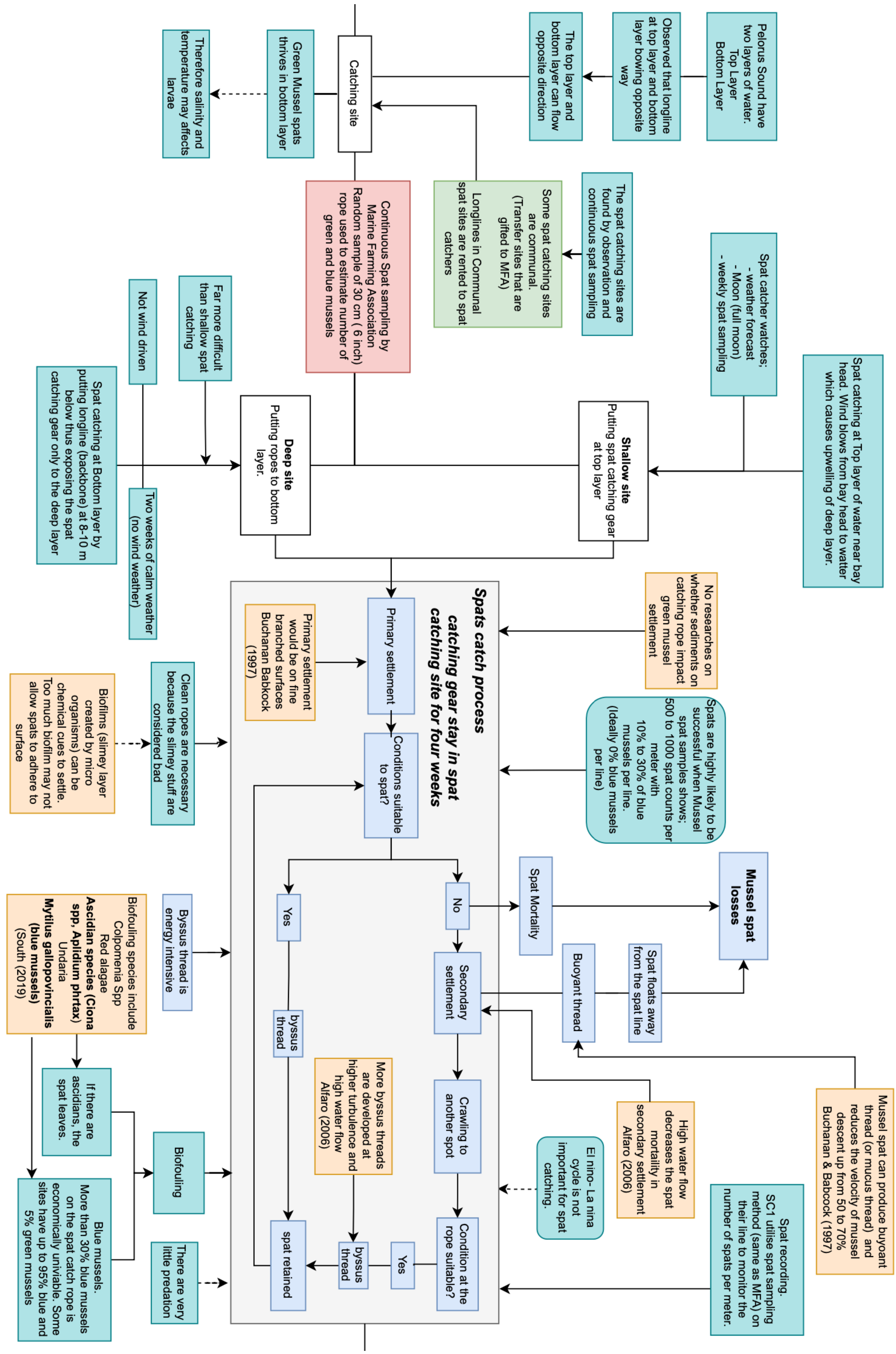
Currently, the spat catchers are relying too heavily on the spat monitoring programme. The MFA monitoring technique is the most important source of information that the spat catchers used. The same technique is used in Wainui Bay and conducted individually as well. Some scientists have used the monitoring data and other variables to develop a predictive model (Atalah & Forrest, 2019). However, SC3, SC4 and SC5 did not utilise the predictive model. It was further unexpected that the spat catchers were not utilising monitoring equipment for spat health, water flow speed, and composition of the water column. The weekly spat monitoring only indicates the number of green and blue mussel settlement on a site. Indeed, it does not give any indication on the sediments, water speed, nor water column effects. Therefore, the current LEK needs to expand on the quantifiable variables. Sensors that can detect water speed, sedimentation level and the water current direction is needed to record the quantifiable variables across all the marine farms and spat catching sites. The quantitative variables can be developed to model the spatiotemporal patterns of mussel larvae across the entire Pelorus Sound (Ruddock, 2020). The same quantifiable variables can be used to develop hypothesis and theories both by scientists and spat catchers to provide discussions. The interaction between spat catcher and scientists with the same data set can lead to a strong discussion which ultimately achieves communicative rationality to have diverse views, a large number of participants and self-interest. The self-interest of spat catchers will be mainly to create profit by developing knowledge and scientists will have more funds if their theories and critical thinking give success to the mussel industry. Consequently, iterative collaborative consensus-building between spat catchers and scientists can occur to co-create knowledge (Innes, 2004).

7.5 The conceptual input-output diagram that reflects LEK

The conceptual diagram represented the diverse perspectives by the spat catching LEK, scientists and planners. The conceptual diagram primarily began with the spat catching operation described in academic literature (Kelly, Pecl, & Fleming, 2017). The regulatory and scientific findings were also added to understand the overlap with the scientific, legislative, regulatory findings. Therefore, the conceptual diagram may not completely reflect the LEK. However, the conceptual diagram suggests that LEK of spat catchers are not sensitive to environmental impacts caused by spat catching except for lashings and floats that land on the beach as rubbishes.

Figure 7.1 and figure 7.2 show that the process of spat catching is relatively similar. All method use fibrous or thin materials such as the Christmas rope or net to induce primary settlement of green mussel larvae. Both locations use spatfall monitoring methods to identify the annual patterns of spats in different depths. Therefore the characteristics of the spat catching equipment are similar and serve a similar function but are tweaked slightly to fit into the local area and personal preferences.

Furthermore, the two planners in the study stated that figure 7.1 and 7.2 do not provide possible environmental impacts generated by spat catching. Planners may have presumed that the LEK holders would know more variables or have gained practical knowledge that shows the environmental impacts of the spat catching. However, as indicated by the conceptual diagram, there are many gaps in academic literature and within LEK. For example, scientists and spat catchers do not know the location of the source population of spat larvae. The LEK rely on the spatfall monitoring method and have not considered developing additional sensors or monitoring technology that accurately monitors the water movements, temperature and salinity. As a result, it is difficult to know whether some spat catching sites or spat holding sites are no longer economically viable and is more difficult to identify better spat catching or holding sites.



Pelorus Sound have two layers of water. Top Layer Bottom Layer
Observed that longline at top layer and bottom layer bowing opposite way
The top layer and bottom layer can flow opposite direction
Catching site
Green Mussel spats thrives in bottom layer
Therefore salinity and temperature may affects larvae
The spat catching sites are found by observation and continuous spat sampling
Some spat catching sites are communal. (Transfer sites that are gifted to MFA) Longlines in Communal spat sites are rented to spat catchers
Continuous Spat sampling by Marine Farming Association Random sample of 30 cm (6 inch) rope used to estimate number of green and blue mussels
Spat catcher watches; - weather forecast - Moon (full moon) - weekly spat sampling
Spat catching at Top layer of water near bay head. Wind blows from bay head to watter which causes upwelling of deep layer.
Shallow site
Putting spat catching gear at top layer
Far more difficult than shallow spat catching
Not wind driven
Deep site
Putting ropes to bottom layer.
Spat catching at Bottom layer by putting longline (backbone) at 8-10 m below thus exposing the spat catching gear only to the deep layer
Two weeks of calm weather (no wind weather)
Spats catch process
catching gear stay in spat catching site for four weeks
No researches on whether sediments on catching rope impact green mussel settlement
Primary settlement
Primary settlement would be on fine branched surfaces Buchanan Babock (1997)
Conditions suitable to spat?
Spats are highly likely to be successful when Mussel spat samples shows; 500 to 1000 spat counts per meter with 10% to 30% of blue mussels per line. (Ideally 0% blue mussels per line)
Clean ropes are necessary because the slimey stuff are considered bad
Biofilms (slimey layer created by micro organisms) can be chemical cues to settle. Too much biofilm may not allow spats to adhere to surface
No
Yes
Spat Mortality
Mussel spat losses
Secondary settlement
Buoyant thread
Spat floats away from the spat line
Byssus thread is energy intensive
Biofouling species include Colpomenia Spp Red alagae Ascidian species (Ciona spp, Aplidium phrtax) Undaria Mytilus galloprovincialis (blue mussels) (South (2019)
byssus thread
More byssus threads are developed at higher turbulence and high water flow Alfaro (2006)
Crawling to another spot
High water flow decreases the spat mortality in secondary settlement Alfaro (2006)
Mussel spat can produce buoyant thread (or mucus thread) and reduces the velocity of mussel descent up from 50 to 70% Buchanan & Babcock (1997)
El nino- La nina cycle is not important for spat catching.
Condition at the rope suitable?
Yes
byssus thread
spat retained
Spat recording. SC1 utilise spat sampling method (same as MFA) on their line to monitor the number of spats per meter.
If there are ascidians, the spat leaves.
Biofouling
There are very little predation
Blue mussels. More than 30% blue mussels on the spat catch rope is economically univiable. Some sites have up to 95% blue and 5% green mussels

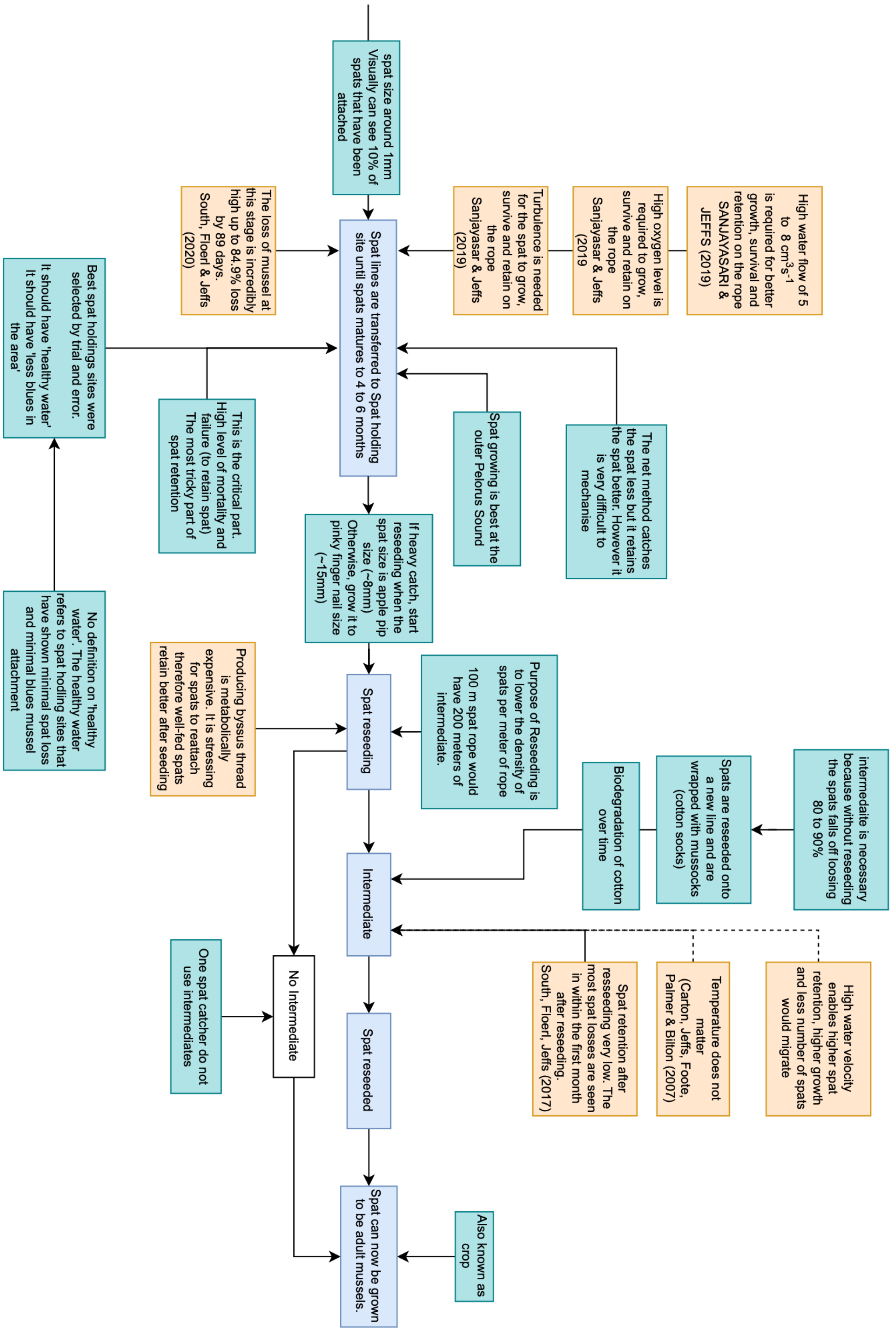
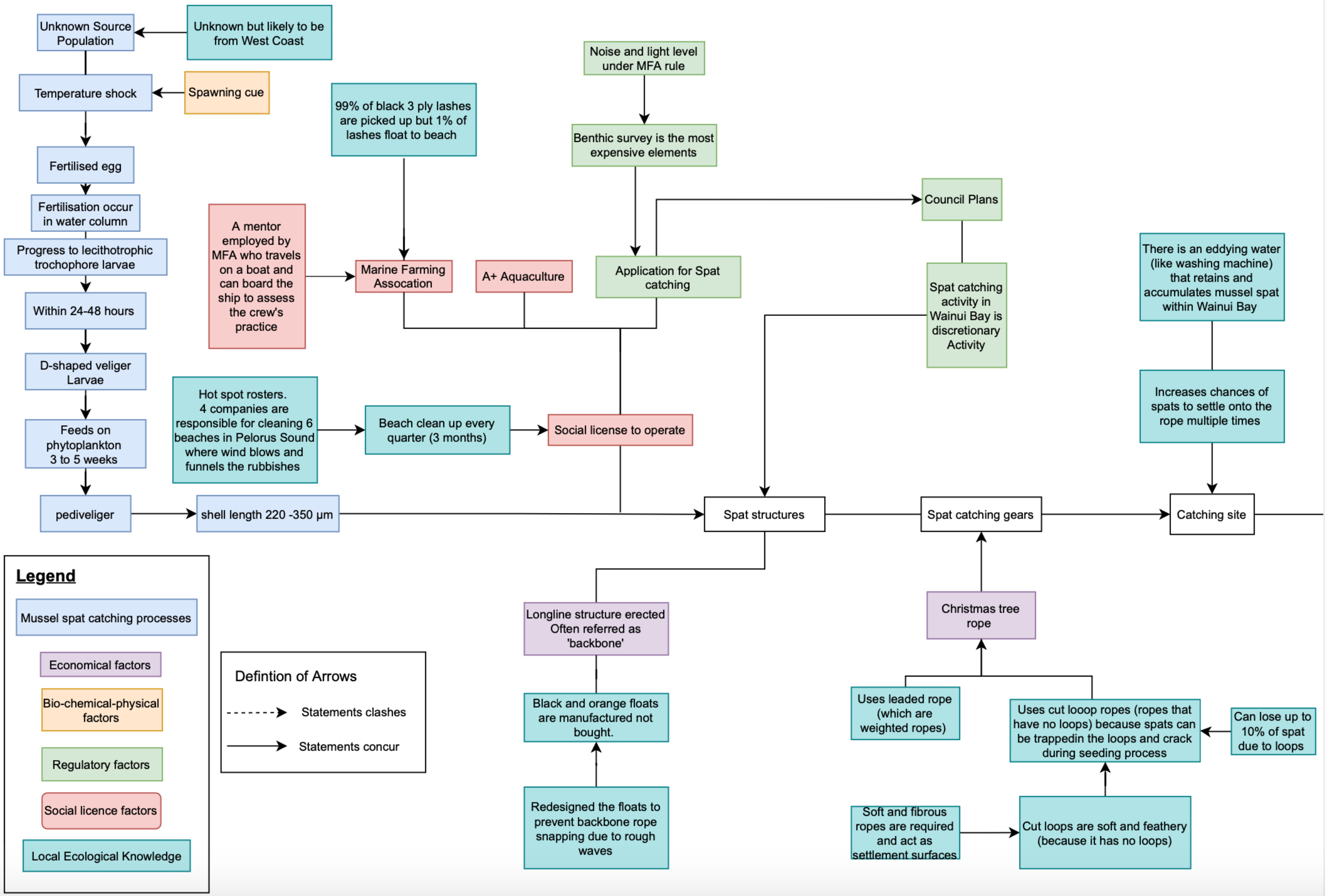
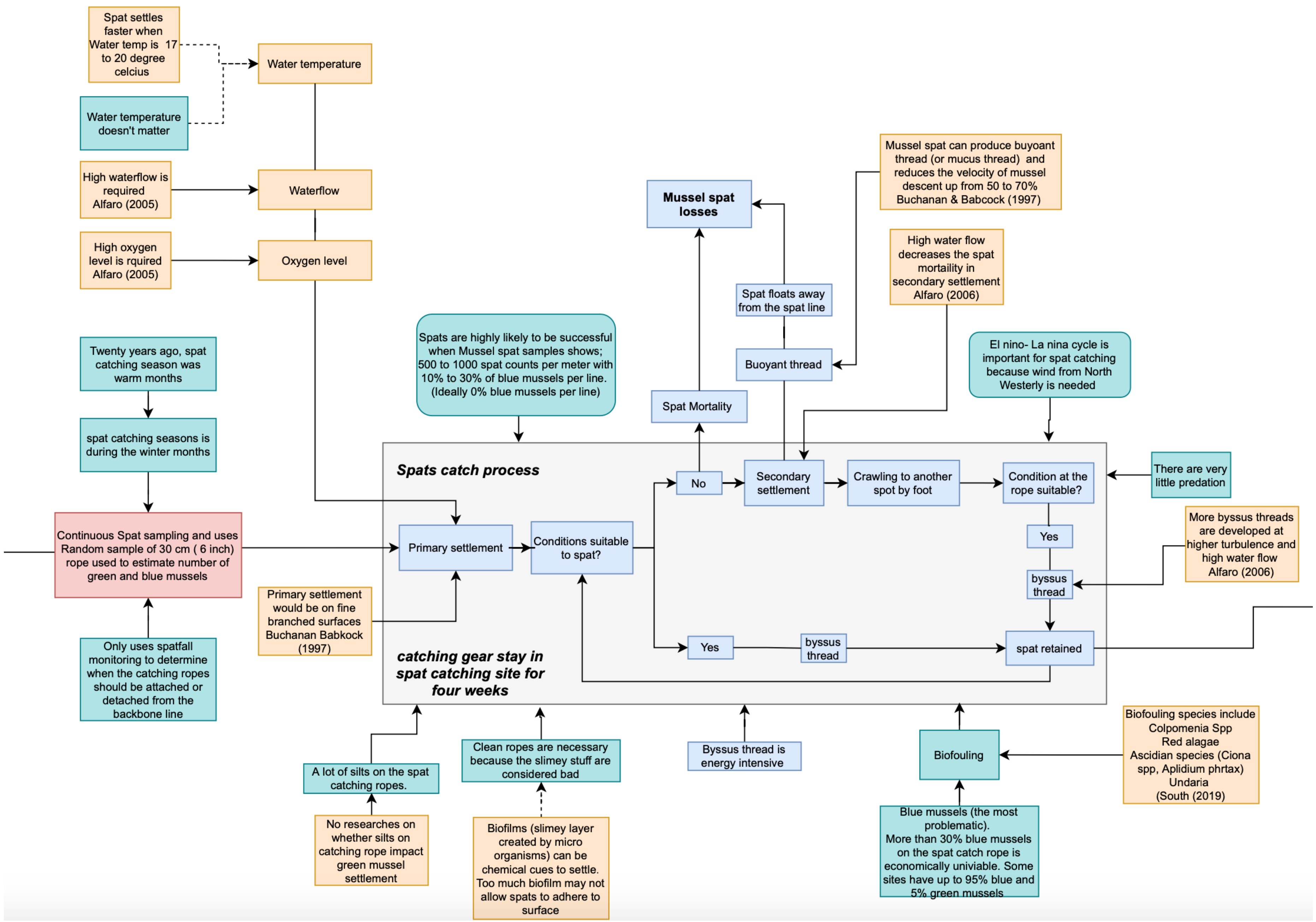


Figure 7.1 Pelorus Sound Spat catching LEK input-output model

Local Ecological Knowledge informed Conceptual model of Wainui Bay spat catching




Spat settles faster when Water temp is 17 to 20 degree celcius
Water temperature doesn't matter
Water temperature
High waterflow is required Alfaro (2005)
Waterflow
High oxygen level is rquired Alfaro (2005)
Oxygen level
Twenty years ago, spat catching season was warm months
spat catching seasons is during the winter months
Continuous Spat sampling and uses Random sample of 30 cm (6 inch) rope used to estimate number of green and blue mussels
Only uses spatfall monitoring to determine when the catching ropes should be attached or detached from the backbone line
Primary settlement would be on fine branched surfaces Buchanan Babkock (1997)
Spats are highly likely to be successful when Mussel spat samples shows; 500 to 1000 spat counts per meter with 10% to 30% of blue mussels per line. (Ideally 0% blue mussels per line)
Mussel spat losses
Spat floats away from the spat line
Buoyant thread
Spat Mortality
Mussel spat can produce buoyant thread (or mucus thread) and reduces the velocity of mussel descent up from 50 to 70% Buchanan & Babcock (1997)
High water flow decreases the spat mortaility in secondary settlement Alfaro (2006)
El nino- La nina cycle is important for spat catching because wind from North Westerly is needed
Spats catch process
Primary settlement
Conditions suitable to spat?
No
Secondary settlement
Crawling to another spot by foot
Condition at the rope suitable?
There are very little predation
Yes
byssus thread
More byssus threads are developed at higher turbulence and high water flow Alfaro (2006)
Yes
byssus thread
spat retained
catching gear stay in spat catching site for four weeks
A lot of silts on the spat catching ropes.
No researches on whether silts on catching rope impact green mussel settlement
Clean ropes are necessary because the slimey stuff are considered bad
Biofilms (slimey layer created by micro organisms) can be chemical cues to settle. Too much biofilm may not allow spats to adhere to surface
Byssus thread is energy intensive
Biofouling
Biofouling species include Colpomenia Spp Red alagae Ascidian species (Ciona spp, Aplidium phrtax) Undaria (South (2019)
Blue mussels (the most problematic). More than 30% blue mussels on the spat catch rope is economically univiable. Some sites have up to 95% blue and 5% green mussels

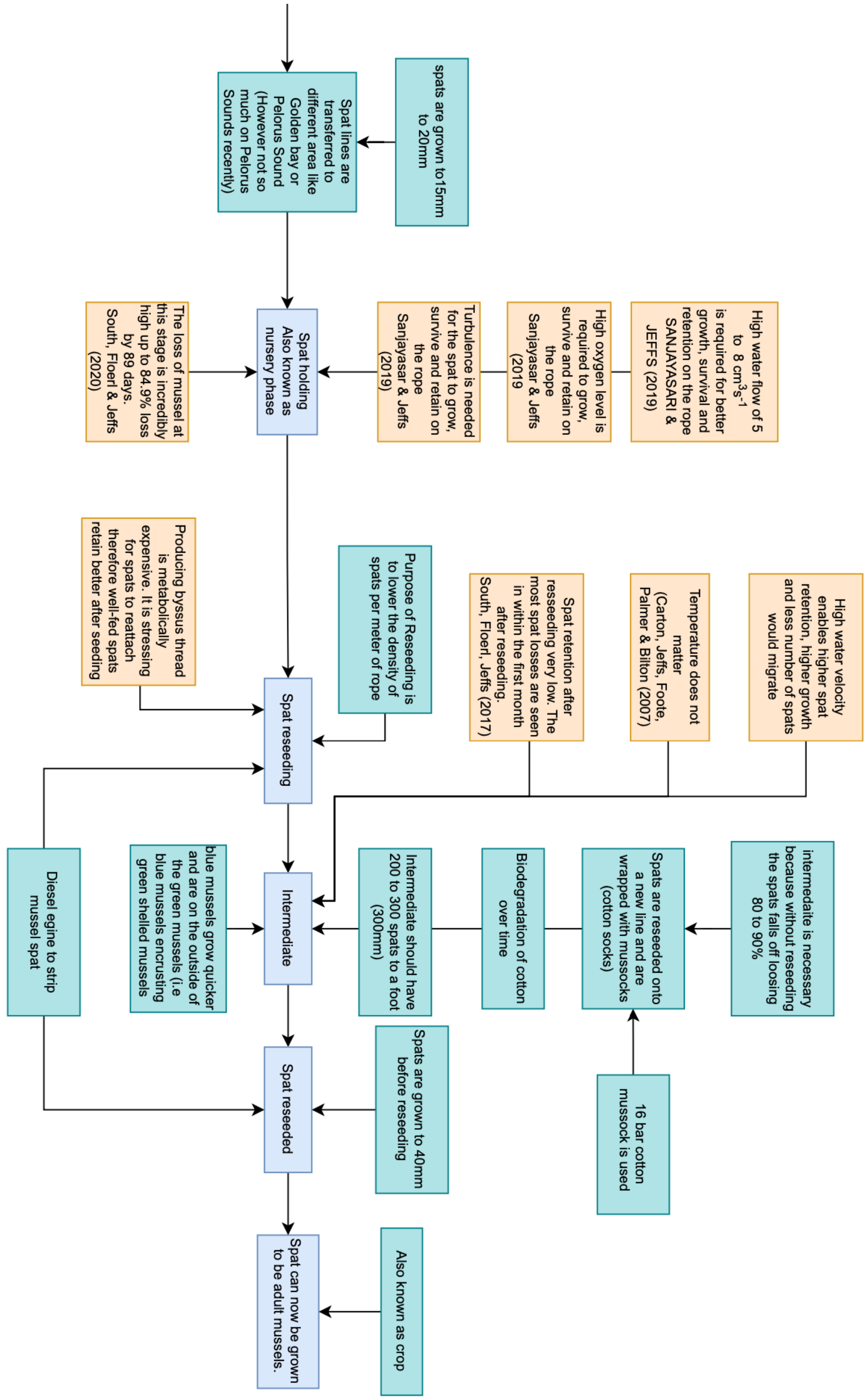


Figure 7.2 Wainui Bay spat catching LEK input-output model.

It was interesting that several scientists already acquired LEK from spat catchers. For example, S6 had exemplified how a spat catcher used more floats to enable vertical movements (section 5.7). Therefore, some spat catchers may be more familiar with working with scientists. Except for Wainui

Bay, there were hardly any interactions between planners and spat catchers which may indicate that co-creation of socio-ecological knowledge may require more effort compared to scientists.

The initial conceptual diagram and its approach could have been improved to capture LEK if spat catcher knowledge evident from hearing evidence was used. For example, AEE documents and For example, change in operational practices were to obtain the social licence to operate to reveal a knowledge that enabled them to address social, environmental issues.

7.6 Summary

From the discussion, LEK in the socio-ecological system can be extended to the socio-ecological system because spat catchers were aware of the changes in regional plans and cost involved and even achieved SLO by complying with the rules from MFA to gain social capital. Surprisingly, the bio-physical elements that LEK Included were the separation of water layer (in Pelorus Sound), water current direction and wind. However, LEK is currently lacking in other quantitative variables to give an understanding of water speed, EL niño and La niña effect, predation. The most notable biofouling specie was the blue mussels. The technology utilised by the spat catchers differed with the geographical locations and the technology changed or improved to increase the profit. Therefore the LEK can be seen as practical knowledge that is adapt to situations by success and failure. It should be noted that the spat catchers are highly reliant on the spatfall monitoring programme thus the spat catchers cannot be perceptive or sensitive to other variables within the water column. Therefore more sensors that can detect various quantifiable variables are required to refine and improve LEK.

The LEK can facilitate planners to understand the dynamics of the socio-ecological environment of P.Canaliculus spat catching. LEK can give spat catching procedures and operations that are based from the ecological understanding, regulation, LEK, SLO and economic viability. As a result, incorporating LEK during the collaborative planning give social, economic and ecological background for scientists and planners who may not have complete understanding of these procedures. It is likely that LEK incorporated planning could give plans and regulations that are more realistic and highly feasible to the local environment and local economy. Even if there are disagreement, the understanding of LEK enable planners to provide context or discussions for local residents and local aquaculture businesses. However facilitation by LEK can be difficutl because the LEK currently lacks in various quantitative variables such as water speed, direction, salinity and water temperature that enable better spat catching or identifying better spat catching. In addition, there are amenity issues by the local residents who do not want spat catching operations due to the ugliness of structures on the water.

Chapter 8
Conclusion

This research examined the extent of LEK that can facilitate the planners to understand the dynamics of the socio-ecological environment of green mussel spat catching. The study examined the Wainui Bay and Pelorus Sound to explore the socio-ecological environment through the lens of LEK. The study utilised the qualitative method and graphic elicitation method. The graphic elicitation was a technique where the author developed an input-output diagram of spat catching operation, a timeline of Acts and flow charts of RMA and FA. Seven planners and seven scientists were interviewed to understand the regulatory environment and scientific understanding of spats. The input-output model was revised, and the four spat catchers were interviewed. Key findings from spat catchers were assembled to develop the two final conceptual model of spat catching operation. The model was sent to planners who gave feedbacks. This research found LEK within the legislative and regulatory environment, the biophysical factors related to spat catching and the spat catching technology.

Both Pelorus Sound and Wainui Bay sites require replacement coastal permits once the current coastal permit expires. The replacement coastal permit regulations more relevant to these areas as new coastal space for spat catching is highly unlikely. Spat catchers were aware of changes to rules in local government. The Pelorus Sound spat catching sites will continue to be controlled if it does not change the structure or catchable species. Due to this, the innovation in spat catching will be constrained to the longline system. New Zealand Coastal Policy Statement 2010 is an essential coastal policy document because the Tasman Resource Management Plan (TRMP) and Marlborough Sound Resource Management Plan (MSRMP) was developed before NZCPS.

Social license to operate (SLO) is a concept that can explain the ways spat catchers have adapted to the community. The entire mussel industry is aware of the environmental impacts generated by the loose black plies. The MFA beach clean up, and hot rosters were used to gain social capital with the public and with the planners. The spat catching sites that will not be deemed as controlled activity in the next resource consent application need to establish SLO to gain replacement coastal permit. Some communities such as Wainui Bay was sensitive to noises and light. The spat catcher in Wainui Bay complied with the rules set by the council and went beyond the requirement to ensure no complaints were made. Liaison meetings were used to communicate and meet the needs of the residents. On the other hand, if the spat catching sites will be deemed as controlled activity, the spat catchers likely to not achieve SLO with the local residents as in Pelorus Sound. Therefore, it can be seen that LEK has integrated the SLO as a mechanism to reduce negative perspectives from the community and public to gain replacement coastal permit.

The LEK of spat catching includes understanding and utilising biophysical factors. The LEK of spat catchers has shown that the water current direction was an important feature. The water current generated by wind causes localised upwelling for shallow spat catching. The “eddying current” or “washing machine effect” caused by Wainui Bay was considered as the most important factor for successful spat catching. El niño and La niña cycle was seen as important for green mussel spat in Wainui Bay but not significantly for Pelorus Sound. In Pelorus Sound, it was associated with blue mussels. Both of these claims were also seen in predictive models developed by Atalah & Forrest (2019) and Atalah, Rabel & Forrest (2017). Water speed, oxygenation and impact forestry industries were inconclusive because mussel larvae are too microscopic and causality may have more variables than the current LEK holders and scientists understand.

The technology of spat catching includes the method, equipment and monitoring data that they utilise. As stated before, the mussel larvae are invisible and take up to 4 weeks before physically observing the spat settlement. Therefore, the spat catchers use spatfall monitoring developed by MFA on both Pelorus Sound and in Wainui Bay to determine the opportunity for spat catching. However, the spat catchers do not utilise any other monitoring devices which limit their LEK. The spat catching method has shown that both shallow and deep spat catching was working under the assumption that the green mussel spats are in the deeper layer.

The primary benefits from this research are not perhaps the original questions about the values of LEK For planners but the value of the diagram in itself and the process that the author went through to develop the map that resulted in a practical and useful tool for planners especially planners who are not familiar with the aquaculture and coastal environment.

It highlights LEK as practical knowledge of a specific area that may not be influenced by spiritual belief or culture. Consequently, LEK of local spat catchers may need to be differentiated to indigenous local knowledge. Furthermore, the research showed that LEK is continuously changed and improved to generate economic success. As a result, their observation and perception aim to identify any elements that may impact the spat catching. Therefore the spat catchers may not necessarily observed or identified how the spat catching influence the environment.

Less well-captured in the diagrams, but evident in the interview and data obtained was the LEK both drew from and can differ from scientific knowledge and was used by spat catchers to have successful spat catching operations. Furthermore, it also has shown that the spat catchers are limited in identifying causes due to the lack of quantitative variables within every localised spat catching sites. Therefore, the co-creation of knowledge can be developed by using technology to measure various quantitative variables to enhance the accuracy of spat catching and spat monitoring. Therefore LEK should not be considered to be frozen in time and space and that these cannot be integrated with other forms of knowledge – it can grow and evolve.

Importantly, this research implies that aquaculture LEK is not limited to ecological understanding. Social expectations and social attitude can impact the behaviour of the LEK holders and consequently alter the operation to meet social expectations in which leads to SLO. Therefore, LEK conceptually needs to expand to the socio-ecological environment. Consequently, the role of aquaculture LEK holders need to be redefined role as local people who can give the local socio-ecological context of particular areas.

The LEK can be limited by the observation, monitoring technology and understanding the specie of interest. This research implies that if the species of interest are too small, the monitoring technology becomes critical. However, it can be seen that the monitoring technology may need to be improved

Aquaculture LEK can be influenced by scientific knowledge. This research implies that LEK holders can incorporate scientific knowledge and test it to become practical knowledge. On the other hand, scientists can also use these data to model to give a more specific understanding.

The use of diagrammatic elicitation could be useful for future researches that involve face-to-face interviews. Annotating diagrams during the interviews enable both the participants and the interviewer to be immersed. Furthermore, the prepared diagrams can improve rapport because it shows that the interviewer have some understanding but wants to learn more. The annotation also enabled participant and interviewer to express with pictures and diagrams thus minmise the chance of misunderstanding.

The author acknowledges that there were limits to this study. The case study overall contained only four spat catchers. Ideally, interviewing more spat catchers would have given a more comprehensive understanding of LEK and LEK differences between spat catchers. A quantitative analysis using spatfall monitoring programme would have confirmed the temporal shifts in the spat settlement behaviour in each monitoring sites. External validity can be limited because the findings in a hidden population may not be applicable (Waters, 2014). This research explored the LEK informed conceptual diagram that can facilitate the aquaculture planning practice.

The subsequent studies need to examine whether various aquaculture LEK, fishery LEK and kaitakitanga system have overlaps and its potential for co-creating knowledge to develop a local collaborative consensus group.

The benefit from this research is may not be relevant to the original question on the value of LEK to the planners but the value of making an input-output diagram that can be used tool for planners who are new to aquaculture. The exact LEK captured in this research may not be directly transferable, but the framework of the conceptual diagram to capture LEK can be adapted to different regions or even to different species.

References

Adams, W. C. (2015). Conducting Semi-Structured Interviews. *Handbook of Practical Program Evaluation*, 492-505. doi: https://doi.org/10.1002/9781119171386.ch19

Alfaro, A. C. (2005). Effect of water flow and oxygen concentration on early settlement of the New Zealand green-lipped mussel, Perna canaliculus. *Aquaculture, 246*(1), 285-294. doi:https://doi.org/10.1016/j.aquaculture.2005.02.049

Alfaro, A. C. (2006). Byssal attachment of juvenile mussels, Perna canaliculus, affected by water motion and air bubbles. *Aquaculture, 255*(1), 357-361. doi:https://doi.org/10.1016/j.aquaculture.2005.11.059

Alfaro, A. C., & Jeffs, A. G. (2003). Variability in mussel settlement on suspended ropes placed at Ahipara Bay, Northland, New Zealand. *Aquaculture, 216*(1), 115-126. doi:https://doi.org/10.1016/S0044-8486(02)00419-2

Aswani, S., Lemahieu, A., & Sauer, W. H. H. (2018). Global trends of local ecological knowledge and future implications. *PLOS ONE, 13*(4), e0195440. doi:10.1371/journal.pone.0195440

Atalah, J., & Forrest, B. M. (2019). Forecasting mussel settlement using historical data and boosted regression trees. *Aquaculture Environment Interactions, 11*, 625-638. Retrieved from https://www.int-res.com/abstracts/aei/v11/p625-638/

Atalah, J., Rabel, H., & Forrest, B. M. (2017). Modelling long-term recruitment patterns of blue mussels Mytilus galloprovincialis: a biofouling pest of green-lipped mussel aquaculture in New Zealand. *Aquaculture Environment Interactions, 9*, 103-114. Retrieved from https://www.int-res.com/abstracts/aei/v9/p103-114/

Baines, J., & Edwards, P. (2018). The role of relationships in achieving and maintaining a social licence in the New Zealand aquaculture sector. *Aquaculture, 485*, 140-146. doi:https://doi.org/10.1016/j.aquaculture.2017.11.047

Bender, M., Floeter, S., & Hanazaki, N. (2013). Do traditional fishers recognise reef fish species declines? Shifting environmental baselines in Eastern Brazil. *Fisheries Management & Ecology, 20*. doi:10.1111/fme.12006

Berkes, F. (2018). *Sacred Ecology* (4th ed.). New York: Routledge.

Booher, D. E., & Innes, J. E. (2002). Network power in collaborative planning. *Journal of Planning Education and Research, 21*(3), 221-236.

Bowen, G. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal, 9*, 27-40. doi:10.3316/QRJ0902027

Buchanan, S., & Babcock, R. (1997). Primary and secondary settlement by the greenshell mussel Perna Canaliculus. *Journal of Shellfish Research, 16*, 71-76.

Carton, A. G., Jeffs, A. G., Foote, G., Palmer, H., & Bilton, J. (2007). Evaluation of methods for assessing the retention of seed mussels (Perna canaliculus) prior to seeding for grow-out. *Aquaculture, 262*(2), 521-527. doi:https://doi.org/10.1016/j.aquaculture.2006.11.026

Chalmers, N., & Fabricius, C. (2007). Expert and Generalist Local Knowledge about Land-cover Change on South Africa's Wild Coast: Can Local Ecological Knowledge Add Value to Science? *Ecology and Society, 12*(1). Retrieved from http://www.jstor.org/stable/26267835

Cordón Lagares, E., García Ordaz, F., & del Hoyo, J. J. G. (2018). Innovation, environmental commitment, internationalization and sustainability: A survival analysis of Spanish marine aquaculture firms. *Ocean & Coastal Management, 151*, 61-68. doi:https://doi.org/10.1016/j.ocecoaman.2017.10.024

Davis, A., & Ruddle, K. (2010). Constructing confidence: rational skepticism and systematic enquiry in local ecological knowledge research. *Ecological Applications, 20*(3), 880-894. doi:https://doi.org/10.1890/09-0422.1

Dawber, C. (2004). *Lines in the water: a history of Greenshell mussel farming in New Zealand*. Blenheim. New Zealand Marine Farming Association.

Edwards, P., & Trafford, S. (2016). Social licence in New Zealand—what is it? Journal of the Royal Society of New Zealand, 46(3-4), 165-180. doi:10.1080/03036758.2016.1186702

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115. doi:10.1111/j.1365-2648.2007.04569.x
Gadgil, M., Olsson, P., Berkes, F., & Folke, C. (2003). Exploring the role of local ecological knowledge in ecosystem management: three case studies. *Navigating social-ecological systems: building resilience for complexity and change, 189*, 209. doi:https://doi.org/10.1017/CBO9780511541957.013
Ganesan, A. M., Alfaro, A. C., Brooks, J. D., & Higgins, C. M. (2010). The role of bacterial biofilms and exudates on the settlement of mussel (Perna canaliculus) larvae. *Aquaculture, 306*(1), 388-392. doi:https://doi.org/10.1016/j.aquaculture.2010.05.007
Gilchrist, G., Mallory, M., & Merkel, F. (2005). Can Local Ecological Knowledge Contribute to Wildlife Management? Case Studies of Migratory Birds. *Ecology and Society, 10*(1). Retrieved from http://www.jstor.org/stable/26267752
Gunton, T. I., & Day, J. C. (2003). The theory and practice of collaborative planning in resource and environmental management. *Environments, 31*(2), 5-20.
Halcomb, E. J., & Davidson, P. M. (2006). Is verbatim transcription of interview data always necessary? *Applied Nursing Research, 19*(1), 38-42. doi:https://doi.org/10.1016/j.apnr.2005.06.001
Hayden, B., & Woods, C. (2011). Effect of water velocity on growth and retention of cultured Greenshell™ mussel spat, Perna canaliculus (Gmelin, 1791). *Aquaculture International, 19*, 957-971. doi:10.1007/s10499-010-9413-9
Healey, P. (1992). Planning through Debate: The Communicative Turn in Planning Theory. *The Town Planning Review, 63*(2), 143-162. Retrieved from http://www.jstor.org/stable/40113141
Healey, P. (1993). The communicative work of development plans. *Environment and Planning B: Planning and Design, 20*(1), 83-104.
Healey, P. (1998). Collaborative planning in a stakeholder society. *The Town Planning Review*, 1-21.
Hill, N. A. O., Michael, K. P., Frazer, A., & Leslie, S. (2010). The utility and risk of local ecological knowledge in developing stakeholder driven fisheries management: The Foveaux Strait dredge oyster fishery, New Zealand. *Ocean & Coastal Management, 53*(11), 659-668. doi:https://doi.org/10.1016/j.ocecoaman.2010.04.011
Innes, J. E. (2004). Consensus Building: Clarifications for the Critics. *Planning Theory, 3*(1), 5-20. doi:10.1177/1473095204042315
Jeffs, A., Holland, R., Hooker, S., & Hayden, B. (1999). Overvew and bibliography of researches on the greenshell mussel Perna canaliculus, form New Zealand waters. . *Journal of Shellfish Research, 18*(2), 347-360.
Jenkins, R. (1979). *Mussel cultivation in the Marlborough Sounds (New Zealand).*1st edition. DavidF. Jones Ltd. Wellington.
Kelly, R., Pecl, G. T., & Fleming, A. (2017). Social licence in the marine sector: A review of understanding and application. *Marine Policy, 81*, 21-28. doi:https://doi.org/10.1016/j.marpol.2017.03.005
Lima, M. S. P., Oliveira, J. E. L., de NÓBrega, M. F., & Lopes, P. F. M. (2017). The use of Local Ecological Knowledge as a complementary approach to understand the temporal and spatial patterns of fishery resources distribution. *Journal of Ethnobiology and Ethnomedicine, 13*(1), 30. doi:10.1186/s13002-017-0156-9
Margerum, R. D. (2002). Collaborative Planning:Building Consensus and Building a Distinct Model for Practice. *Journal of Planning Education and Research, 21*(3), 237-253. doi:10.1177/0739456x0202100302
Markle, D., West, R., & Rich, P. (2011). Beyond Transcription: Technology, Change, and Refinement of Method. *Forum Qualitative Sozialforschung, 12*. doi: https://doi.org/10.17169/fqs-12.3.1564
Mayring, P. (2000). Qualitative Content Analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [On-line Journal], http://qualitative-research.net/fqs/fqs-e/2-00inhalt-e.htm, 1*.
Mazzocchi, F. (2006). Western science and traditional knowledge. *EMBO reports, 7*(5), 463-466. doi:https://doi.org/10.1038/sj.embor.7400693

McGuirk, P. M. (2001). Situating Communicative Planning Theory: Context, Power, and Knowledge. *Environment and Planning A: Economy and Space, 33*(2), 195-217. doi:10.1068/a3355
McIntosh, M. J., & Morse, J. M. (2015). Situating and Constructing Diversity in Semi-Structured Interviews. *Global Qualitative Nursing Research, 2*, 2333393615597674. doi:10.1177/2333393615597674
Ministry for Primary Industries. (2020). *Undue adverse effect test.* Retrieved from https://www.mpi.govt.nz/fishing-aquaculture/aquaculture/setting-up-a-marine-farm/undue-adverse-effects-test/
Murray, G., Neis, B., & Johnsen, J. P. (2006). Lessons Learned from Reconstructing Interactions Between Local Ecological Knowledge, Fisheries Science, and Fisheries Management in the Commercial Fisheries of Newfoundland and Labrador, Canada. *Human Ecology, 34*(4), 549-571. doi:10.1007/s10745-006-9010-8
Newton, M., Farrelly, T., & Sinner, J. (2020). Discourse, agency, and social license to operate in New Zealand's marine economy. *Ecology and Society*, 25(1). doi:10.5751/ES-11304-250102
Olsson, P., & Folke, C. (2001). Local Ecological Knowledge and Institutional Dynamics for Ecosystem Management: A Study of Lake Racken Watershed, Sweden. *Ecosystems, 4*(2), 85-104. doi:10.1007/s100210000061
Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences, 104*(39), 15181-15187. doi:10.1073/pnas.0702288104
Parker, C., Scott, S., & Geddes, A. (2019). Snowball Sampling. In P. Atkinson, S. Delamont, A. Cernat & J. W. Sakshaug. *SAGE Research Methods Foundations* (pp 3-12). doi:http://dx.doi.org/10.4135/9781526421036831710
Peng, W., Lam, S. S., & Sonne, C. (2020). Support Austria's glyphosate ban. *Science, 367*(6475), 257-258.
Quigley, R., Baines, J. (2014). *How to improve your social licence: A New Zealand industry perspective.* (MPI Information Paper No: 2014/05). Wellington, Ministry for Primary Industries. Retrieved from https://www.mpi.govt.nz/dmsdocument/3995/direct
Qu Sandy, Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management, 8*(3), 238-264. doi:10.1108/11766091111162070
Rennie, H. G. (2002). *A geography of marine farming rights in New Zealand: Some rubbings of patterns on the face of the sea* ((Unpublished PhD dissertation)). University of Waikato, Hamilton, New Zealand.
Rennie, H. G. (2006). New Zealand Mariculture: Unfarly Challenged? In D. L. VanderZwaag & G. Chao (Eds.), *Aquaculture Law and Policy: Twoards Principled Access and Operations* (pp. 504-523). London and New York: Routledge,.
Rennie, H. G. (2009). Aquaculture management areas - an example of why we should not rush to ditch the RMA's effects-based approach? *Planning quarterly*(174), 14-16.
Rennie, H. G. (2010). Marine (Aquaculture) Space Allocation: Assessing Transitional Challenges to Local Economies in New Zealand. *Local Economy, 25*(3), 190-207. doi:10.1080/02690941003784234
Rennie, H. G., White, R., & Brabyn, L. (2009). Developing a conceptual model of marine farming in New Zealand. *Marine Policy, 33*(1), 106-117. doi:https://doi.org/10.1016/j.marpol.2008.05.001
Ridder, H.-G. (2017). The theory contribution of case study research designs. *Business Research, 10*(2), 281-305. doi:10.1007/s40685-017-0045-z
Ruddle, K., & Davis, A. (2013). Local Ecological Knowledge (LEK) in Interdisciplinary Research and Application: A Critical Review. *Asian Fisheries Science, 26*, 79-100.
Sanjayasari, D., & Jeffs, A. (2019). Optimising environmental conditions for nursery culture of juvenile Greenshell™ mussels (Perna canaliculus). *Aquaculture, 512*, 734338. doi:10.1016/j.aquaculture.2019.734338
South, P. M., Floerl, O., & Jeffs, A. G. (2017). Differential effects of adult mussels on the retention and fine-scale distribution of juvenile seed mussels and biofouling organisms in long-line aquaculture. *Aquaculture Environment Interactions, 9*, 239-256.

Stake, R. E. (2005). Qualitative Case Studies. In *The Sage handbook of qualitative research, 3rd ed.* (pp. 443-466). Thousand Oaks, CA: Sage Publications Ltd.

Stake, R. E. (2008). Qualitative case studies. In *Strategies of qualitative inquiry, 3rd ed.* (pp. 119-149). Thousand Oaks, CA, US: Sage Publications, Inc.

Sullivan, J. (2012). Skype: An appropriate method of data collection for qualitative interviews? *The Hilltop Review*, 6(1), 54–60. Retrieved from https://scholarworks.wmich.edu/hilltopreview/vol6/iss1/10

Tewdwr-Jones, M., & Allmendinger, P. (1998). Deconstructing Communicative Rationality: A Critique of Habermasian Collaborative Planning. *Environment and Planning A: Economy and Space, 30*(11), 1975-1989. doi:10.1068/a301975

Thurmond, V. A. (2001). The Point of Triangulation. *Journal of Nursing Scholarship, 33*(3), 253-258. doi:https://doi.org/10.1111/j.1547-5069.2001.00253.x

Umoquit, M. J., Dobrow, M. J., Lemieux-Charles, L., Ritvo, P. G., Urbach, D. R., & Wodchis, W. P. (2008). The efficiency and effectiveness of utilizing diagrams in interviews: an assessment of participatory diagramming and graphic elicitation. *BMC Medical Research Methodology, 8*(1), 53. doi:10.1186/1471-2288-8-53

Urlich, S. C., & Handley, S. J. (2020). From ‘clean and green’ to ‘brown and down’: A synthesis of historical changes to biodiversity and marine ecosystems in the Marlborough Sounds, New Zealand. *Ocean & Coastal Management, 198*, 105349. doi:https://doi.org/10.1016/j.ocecoaman.2020.105349

Wijsman, J. W. M., Troost, K., Fang, J., & Roncarati, A. (2019). Global Production of Marine Bivalves. Trends and Challenges. In A. C. Smaal, J. G. Ferreira, J. Grant, J. K. Petersen, & Ø. Strand (Eds.), *Goods and Services of Marine Bivalves* (pp. 7-26). Cham: Springer International Publishing.

Yin, R. K. (2014). *Case study research : design and methods* (Fifth edition.. ed.): Los Angeles : SAGE.

Appendix A

Interview Questions for spat catchers

A.1 Interview Questions with Scientists

- Ask questions in reference to their academic literatures.
- What are the main environmental factors that affect your spat catching?
    - Does wind direction matter for spat catching? Why?
    - Current direction? Why?
    - Water temperature? Why? Have water temperature changed over the years?
    - In my study, they say that salinity also matters, is this true?
    - Are there any relevant literatures that I should look? And Why?
    - (Using input-output diagram) Are there any factors that influence green mussel spat that are missing?
- Experiences with spat catchers or commercial mussel spat sites
    - Do you interact with spat catchers?
    - Are there any observations by spat catchers, you feel it is valid or should be studied?

A.2 Interview Questions with Planners

- What are the different regulations under the RMA or other legislation (such as navigation and safety) that have affected the spat catching?
    - What other regulations affect the spat catching? RMA? Fishery? Are there other legislations that affect you?
    - Which rule are most relevant?
    - Have these regulations changed the way the spat was caught?
- Do application for spat catching occur frequently?

- How do community react to spat catching aquaculture (reference to Wainui Bay)
    - Do lights matter? (like in Wainui bay?)
    - Do noise matter (Important to ask for Pelorus Sound one)
- Are there particular social or local customs that needs to be looked for spat catching site consents?
- (Looking at the timeline) Have you ever encountered any of these laws in the timeline that made significant contribution?

A.3 Interview Questions with Spat Catchers

Essential environmental factors that enables successful spat catching

- Could you tell me how you catch spats?
    - Are there specific methods of putting out your lines? Why do you do it that way?
- What are the main environmental factors that affect your spat catching?
    - Does wind direction matter for spat catching? Why?
    - Current direction? Why?
    - Do you look for water temperature? Why? Have water temperature changed over the years?
    - In my study, they say that salinity also matters, is this true?
- (Using a map) Is this where your spat farm is? Why did you choose this location for your spat catching?
    - (prompt: In case they do not mention environmental factors): What environmental factors led to you choose this site?
    - (If the farm is used for more than spat catching) Which are the spat catching lines? Is there a reason why you have located your spat lines here (use of map)?
    - Did you ever have to move the spat lines? Was there a reason?

- (Using a calendar) When do you start catching spat? Why then? (prompt: are there environmental factors that tell you this is the time to start catching?)
- Do you keep the same number of lines in the same formation in the water from the first day to the last? (If not, why not?)
- How often do you take in lines and put them back out again (if you do this)
- How long is the season usually? What would make it vary?
- What behavioural and biological factors are used to catch spats?
    - How do you make sure that mussel spats settle?
    - Do spat move after they first settle or do they stay where they first settle? Does this affect how you catch spat? How do you make sure that they stay on the line?
- (Using a timeline) What are the major events over time that have affected spat catching? (Prompt each of the following: environmental, regulatory, technological, market, social).

Technological and operational factors

- What are the different technologies that are deployed to catch and store spat? Have these technologies fundamentally changed the spat catching over time? In What way? Have these overall caught more spats per line? (i.e improved spat catch rate?)
- What are the big differences between big companies and individual small spat catchers?
    - Are the methods of catching spats different? If so, how and why?
    - Are there synergies between big companies and individual small spat catchers? If, so how and why?
- Have you ever consulted or talked to scientists on more efficient spat catching methods? Has this affected your operation?

Regulatory factors

- What are the different regulations under the RMA or other legislation (such as navigation and safety) that have affected the spat catching?

- What other regulations affect the spat catching? RMA? Fishery? Are there other legislations that affect you?
- Are there regulation set by council that you follow?
- Have these regulations changed the way you catch spats? How did you adapt?
- Did you provide information to the authorities making the regulations (e.g through submissions).

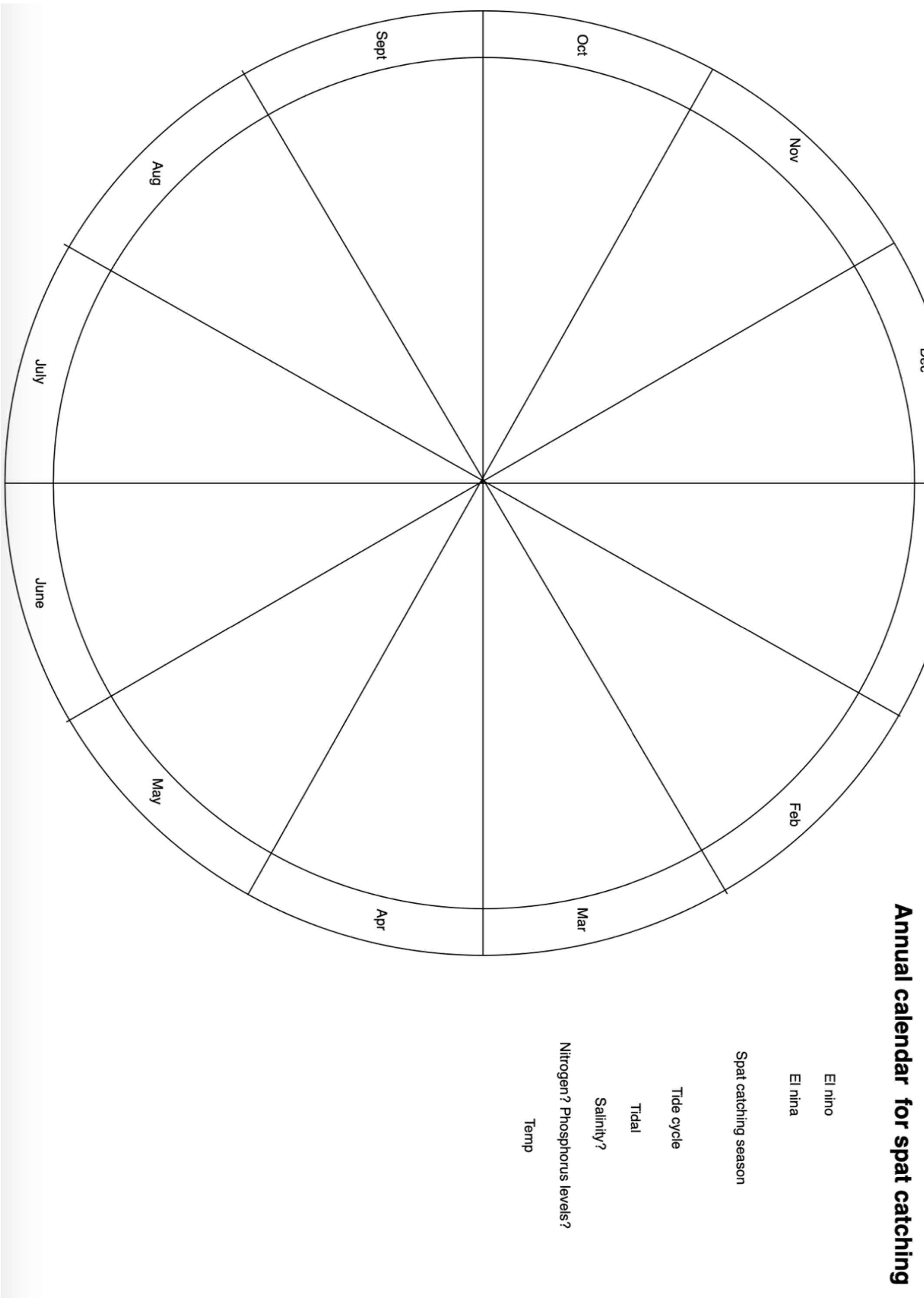
Social factors

- Are there particular social or local customs that could be affecting the spat catch rate?
- For example, do people readily share accurate information about environmental factors? Do they warn or teach other about particular hazards (e.g pollution events, water temperature changes?) Do spat catcher have their own network or community?

Appendix B

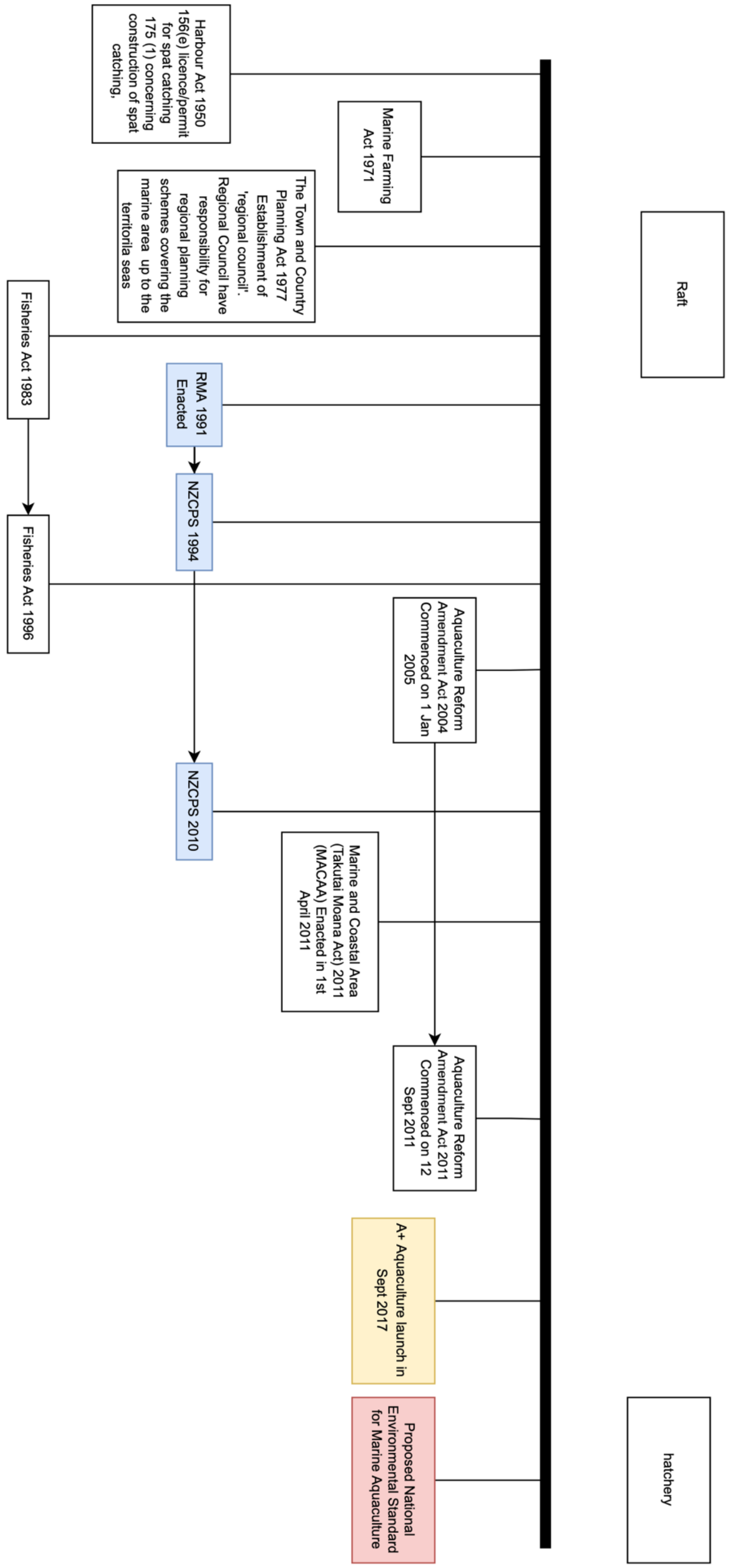
Circular annual Calendar

The Circular annual calendar for annotation during the interview. A list of possible factors were listed beside the annual calendar for the participants to see.



Appendix C

Timeline of Acts

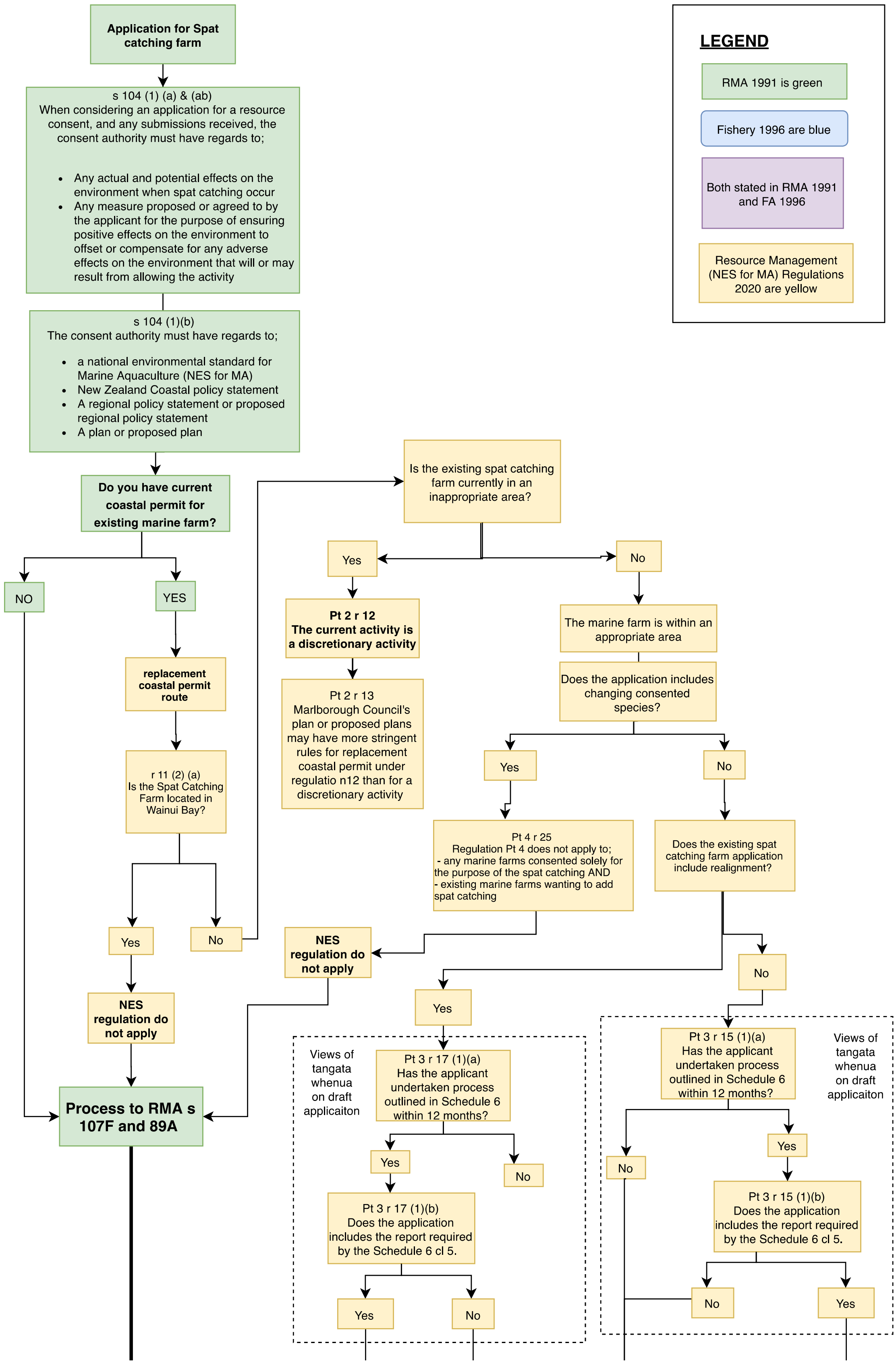


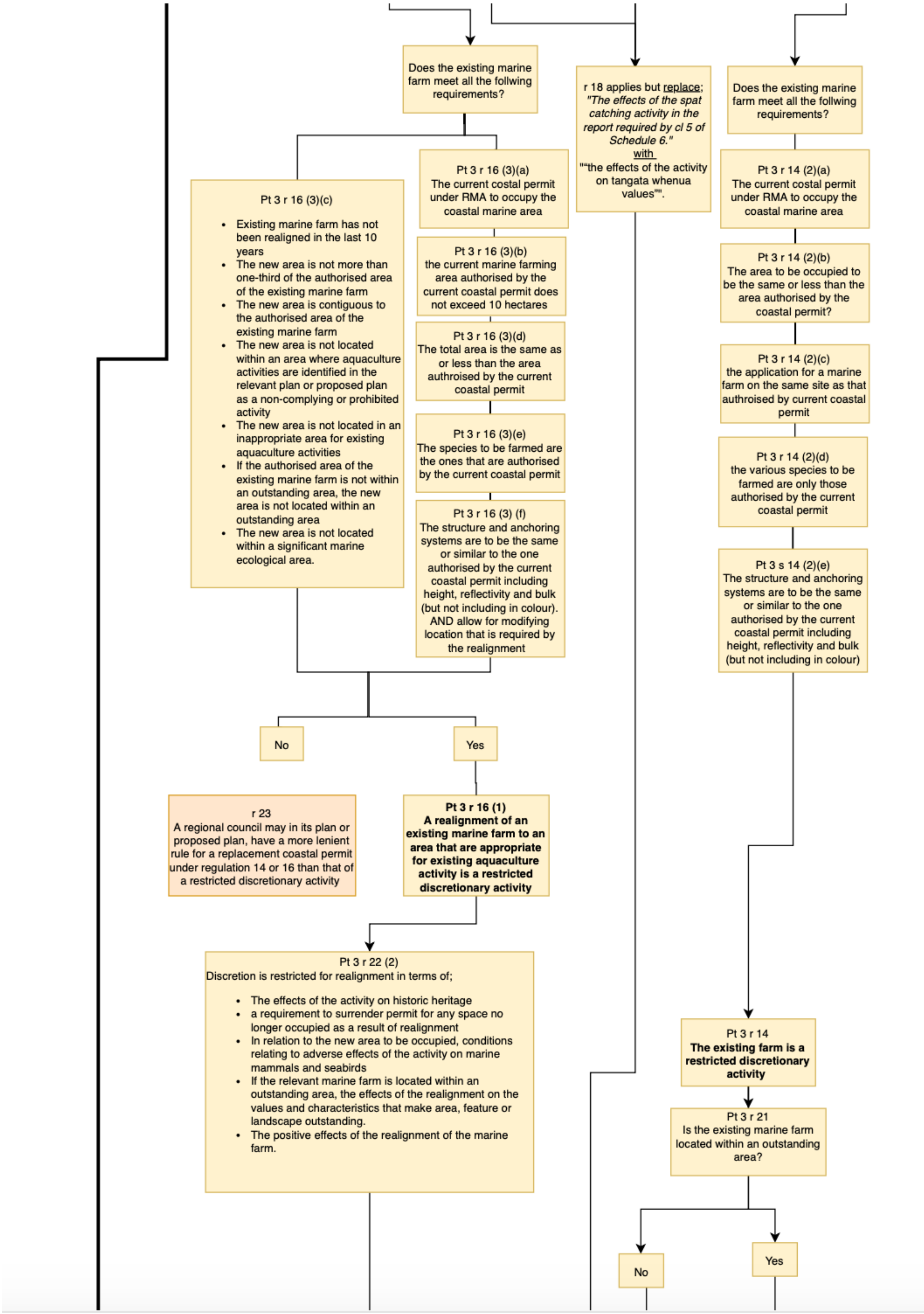
Appendix D

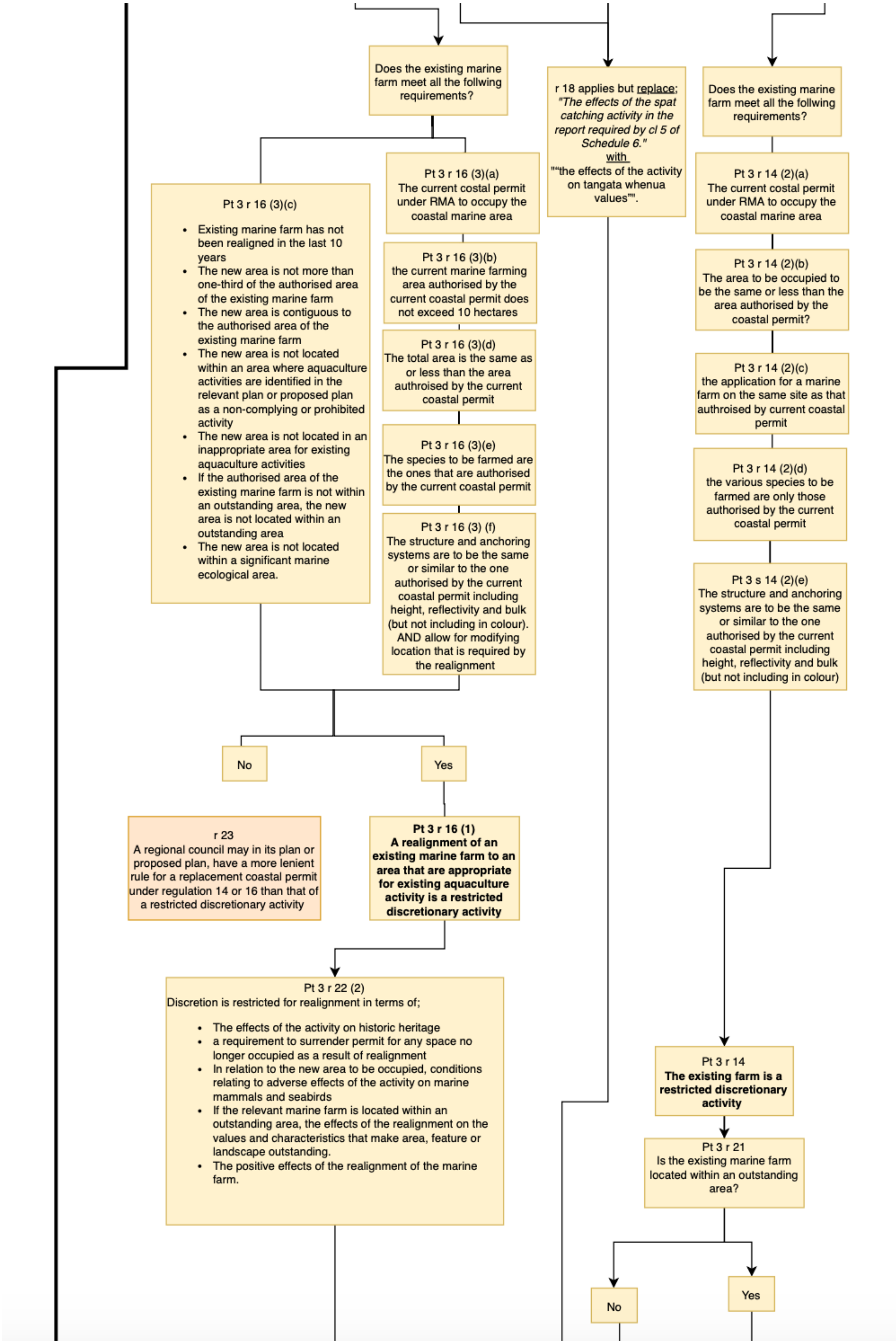
RMA – FA dual coastal permit flow chart

The diagram is 7 pages long and is continuous to the end.

The diagram starts from next page.


Application for Spat catching farm
s 104 (1) (a) & (ab)
When considering an application for a resource consent, and any submissions received, the consent authority must have regards to;
• Any actual and potential effects on the environment when spat catching occur
• Any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity
s 104 (1)(b)
The consent authority must have regards to;
• a national environmental standard for Marine Aquaculture (NES for MA)
• New Zealand Coastal policy statement
• A regional policy statement or proposed regional policy statement
• A plan or proposed plan
Do you have current coastal permit for existing marine farm?
NO
YES
replacement coastal permit route
r 11 (2) (a)
Is the Spat Catching Farm located in Wainui Bay?
Yes
No
NES regulation do not apply
Process to RMA s 107F and 89A
Is the existing spat catching farm currently in an inappropriate area?
Yes
No
Pt 2 r 12
The current activity is a discretionary activity
Pt 2 r 13
Marlborough Council's plan or proposed plans may have more stringent rules for replacement coastal permit under regulatio n12 than for a discretionary activity
The marine farm is within an appropriate area
Does the application includes changing consented species?
Yes
No
Pt 4 r 25
Regulation Pt 4 does not apply to;
- any marine farms consented solely for the purpose of the spat catching AND
- existing marine farms wanting to add spat catching
Does the existing spat catching farm application include realignment?
NES regulation do not apply
Yes
No
Views of tangata whenua on draft applicaiton
Pt 3 r 17 (1)(a)
Has the applicant undertaken process outlined in Schedule 6 within 12 months?
Yes
No
Pt 3 r 17 (1)(b)
Does the application includes the report required by the Schedule 6 cl 5.
Yes
No
Pt 3 r 15 (1)(a)
Has the applicant undertaken process outlined in Schedule 6 within 12 months?
Views of tangata whenua on draft applicaiton
No
Yes
Pt 3 r 15 (1)(b)
Does the application includes the report required by the Schedule 6 cl 5.
No
Yes
LEGEND
RMA 1991 is green
Fishery 1996 are blue
Both stated in RMA 1991 and FA 1996
Resource Management (NES for MA) Regulations 2020 are yellow


Does the existing marine farm meet all the follwing requirements?
r 18 applies but replace; "The effects of the spat catching activity in the report required by cl 5 of Schedule 6." with ""the effects of the activity on tangata whenua values"".
Does the existing marine farm meet all the follwing requirements?
Pt 3 r 16 (3)(c)
• Existing marine farm has not been realigned in the last 10 years
• The new area is not more than one-third of the authorised area of the existing marine farm
• The new area is contiguous to the authorised area of the existing marine farm
• The new area is not located within an area where aquaculture activities are identified in the relevant plan or proposed plan as a non-complying or prohibited activity
• The new area is not located in an inappropriate area for existing aquaculture activities
• If the authorised area of the existing marine farm is not within an outstanding area, the new area is not located within an outstanding area
• The new area is not located within a significant marine ecological area.
Pt 3 r 16 (3)(a) The current costal permit under RMA to occupy the coastal marine area
Pt 3 r 16 (3)(b) the current marine farming area authorised by the current coastal permit does not exceed 10 hectares
Pt 3 r 16 (3)(d) The total area is the same as or less than the area authroised by the current coastal permit
Pt 3 r 16 (3)(e) The species to be farmed are the ones that are authorised by the current coastal permit
Pt 3 r 16 (3) (f) The structure and anchoring systems are to be the same or similar to the one authorised by the current coastal permit including height, reflectivity and bulk (but not including in colour). AND allow for modifying location that is required by the realignment
Pt 3 r 14 (2)(a) The current costal permit under RMA to occupy the coastal marine area
Pt 3 r 14 (2)(b) The area to be occupied to be the same or less than the area authorised by the coastal permit?
Pt 3 r 14 (2)(c) the application for a marine farm on the same site as that authroised by current coastal permit
Pt 3 r 14 (2)(d) the various species to be farmed are only those authorised by the current coastal permit
Pt 3 s 14 (2)(e) The structure and anchoring systems are to be the same or similar to the one authorised by the current coastal permit including height, reflectivity and bulk (but not including in colour)
No
Yes
r 23 A regional council may in its plan or proposed plan, have a more lenient rule for a replacement coastal permit under regulation 14 or 16 than that of a restricted discretionary activity
Pt 3 r 16 (1) A realignment of an existing marine farm to an area that are appropriate for existing aquaculture activity is a restricted discretionary activity
Pt 3 r 22 (2) Discretion is restricted for realignment in terms of;
• The effects of the activity on historic heritage
• a requirement to surrender permit for any space no longer occupied as a result of realignment
• In relation to the new area to be occupied, conditions relating to adverse effects of the activity on marine mammals and seabirds
• If the relevant marine farm is located within an outstanding area, the effects of the realignment on the values and characteristics that make area, feature or landscape outstanding.
• The positive effects of the realignment of the marine farm.
Pt 3 r 14 The existing farm is a restricted discretionary activity
Pt 3 r 21 Is the existing marine farm located within an outstanding area?
No
Yes


Does the existing marine farm meet all the follwing requirements?
r 18 applies but replace; "The effects of the spat catching activity in the report required by cl 5 of Schedule 6." with ""the effects of the activity on tangata whenua values"".
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Pt 3 r 16 (3)(c)
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Pt 3 r 16 (3)(e) The species to be farmed are the ones that are authorised by the current coastal permit
Pt 3 r 16 (3) (f) The structure and anchoring systems are to be the same or similar to the one authorised by the current coastal permit including height, reflectivity and bulk (but not including in colour). AND allow for modifying location that is required by the realignment
Pt 3 r 14 (2)(a) The current costal permit under RMA to occupy the coastal marine area
Pt 3 r 14 (2)(b) The area to be occupied to be the same or less than the area authrised by the coastal permit?
Pt 3 r 14 (2)(c) the application for a marine farm on the same site as that authroised by current coastal permit
Pt 3 r 14 (2)(d) the various species to be farmed are only those authorised by the current coastal permit
Pt 3 s 14 (2)(e) The structure and anchoring systems are to be the same or similar to the one authorised by the current coastal permit including height, reflectivity and bulk (but not including in colour)
No
Yes
r 23 A regional council may in its plan or proposed plan, have a more lenient rule for a replacement coastal permit under regulation 14 or 16 than that of a restricted discretionary activity
Pt 3 r 16 (1) A realignment of an existing marine farm to an area that are appropriate for existing aquaculture activity is a restricted discretionary activity
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In relation to the new area to be occupied, conditions relating to adverse effects of the activity on marine mammals and seabirds
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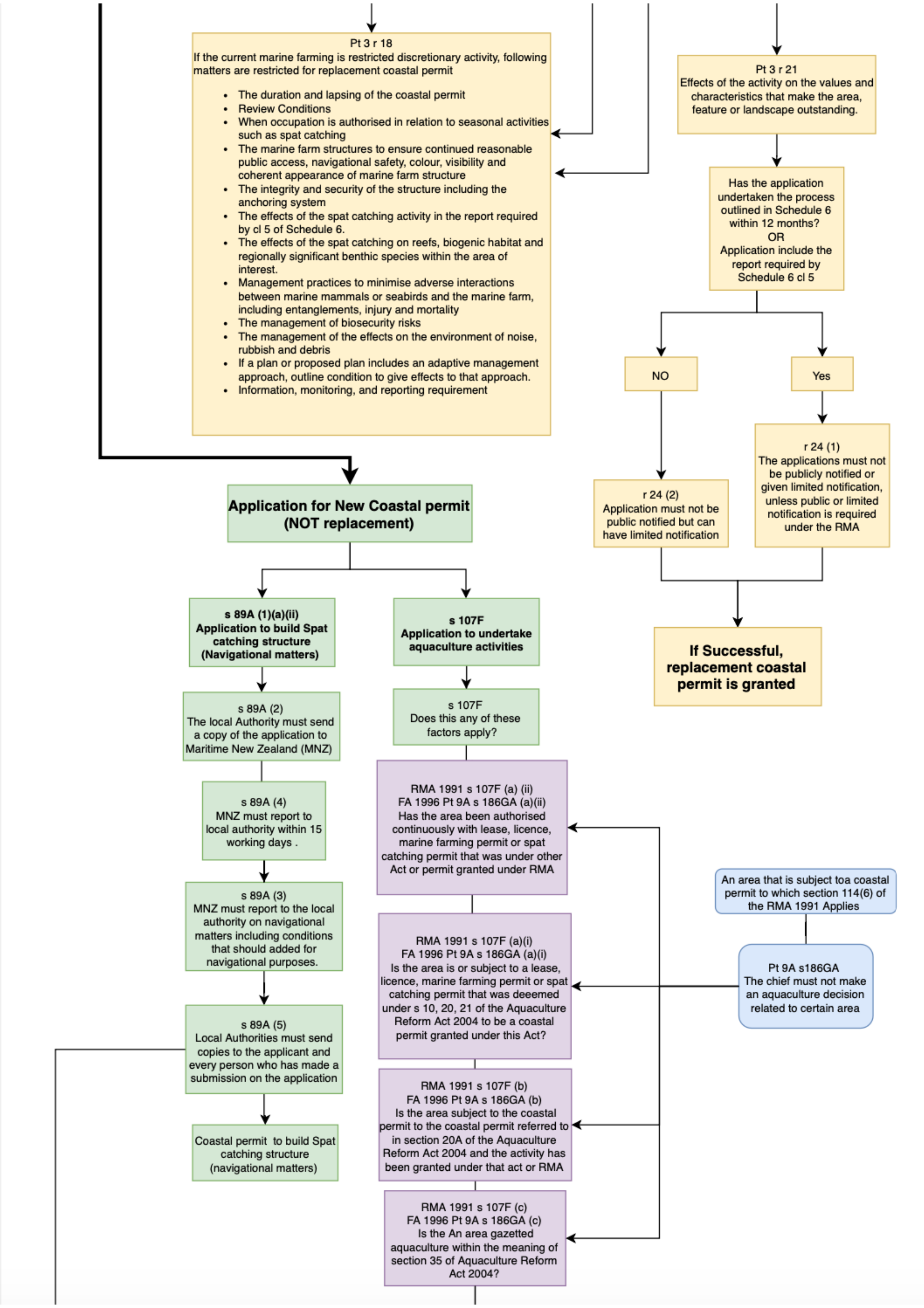
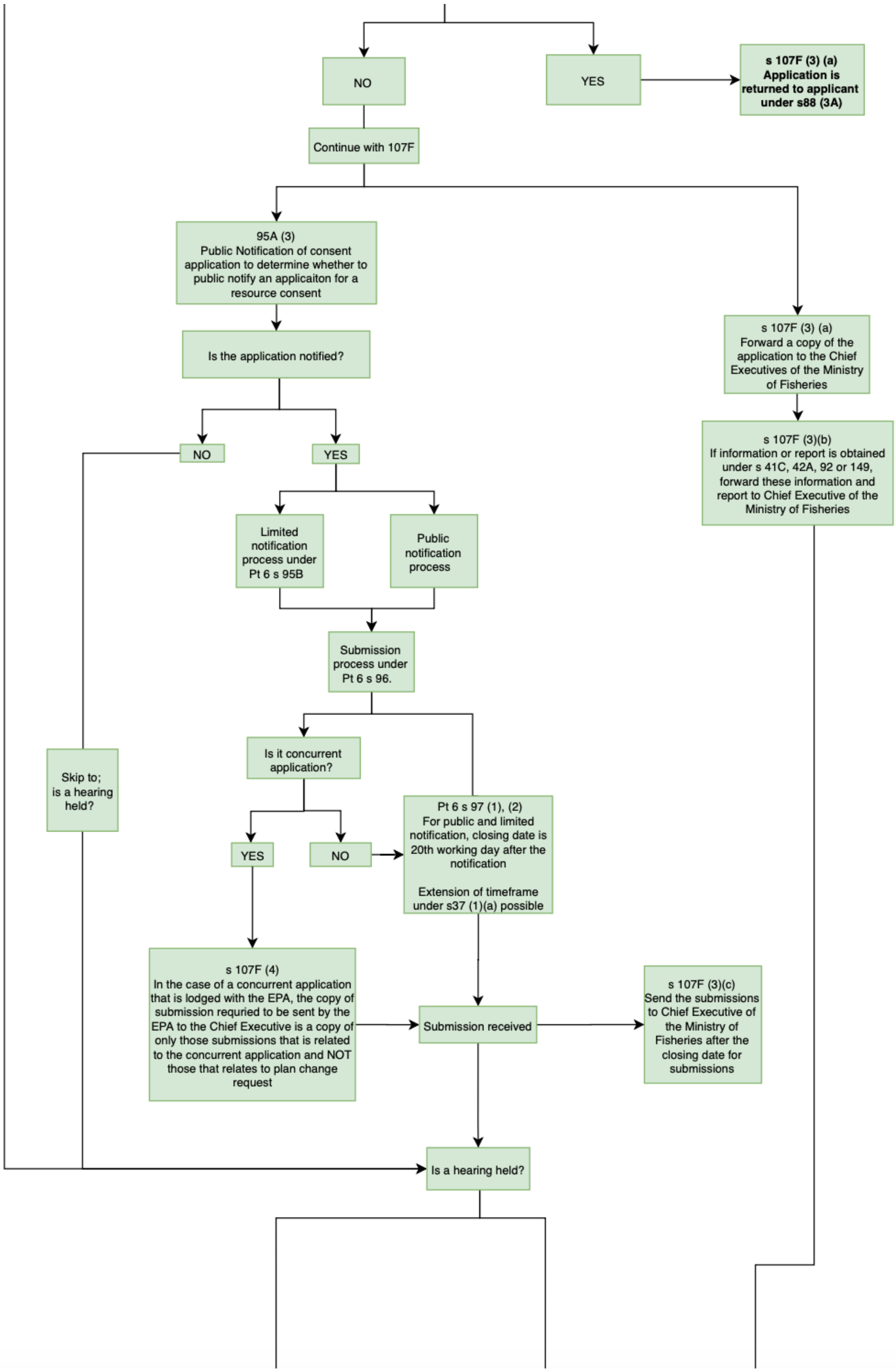
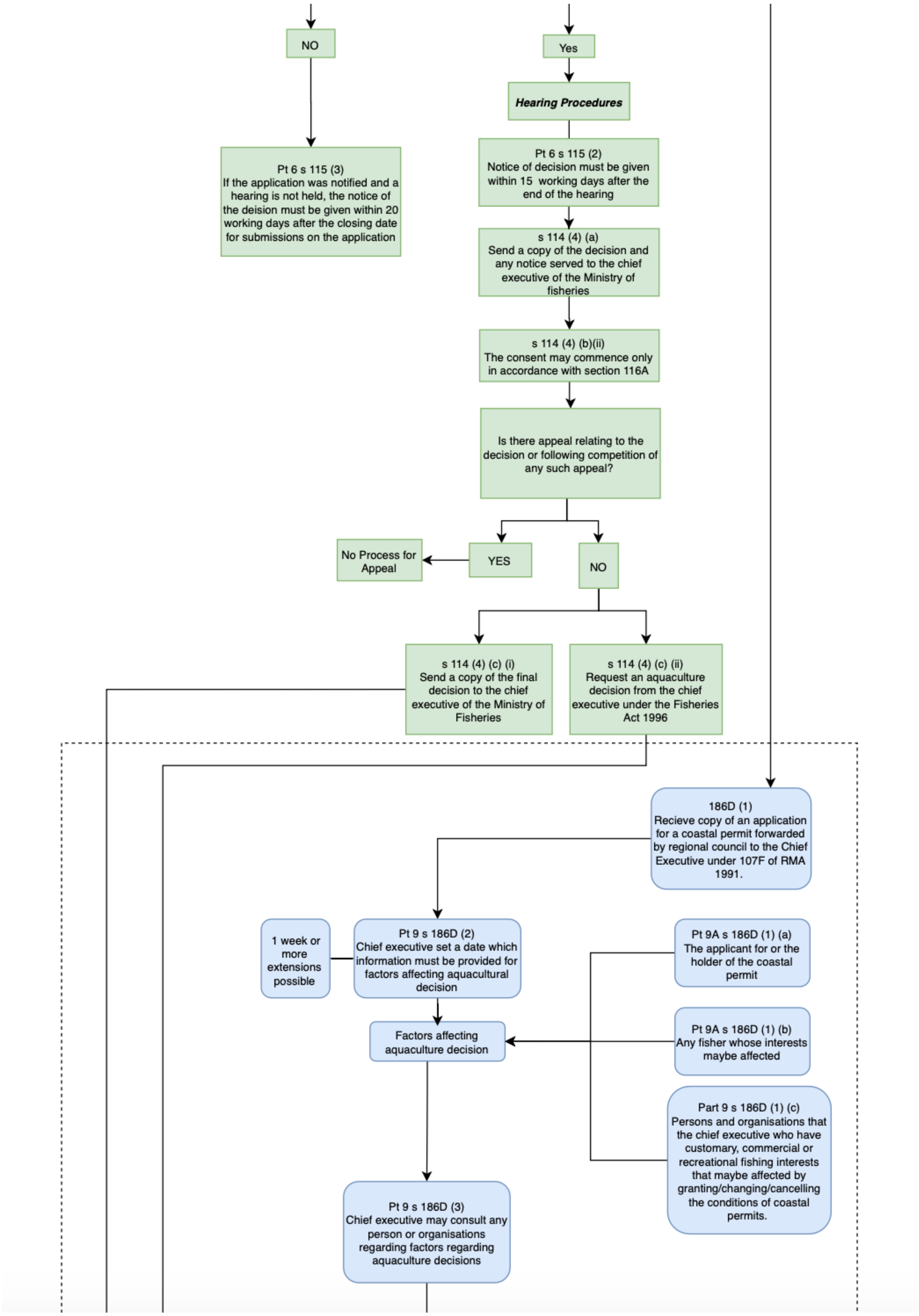
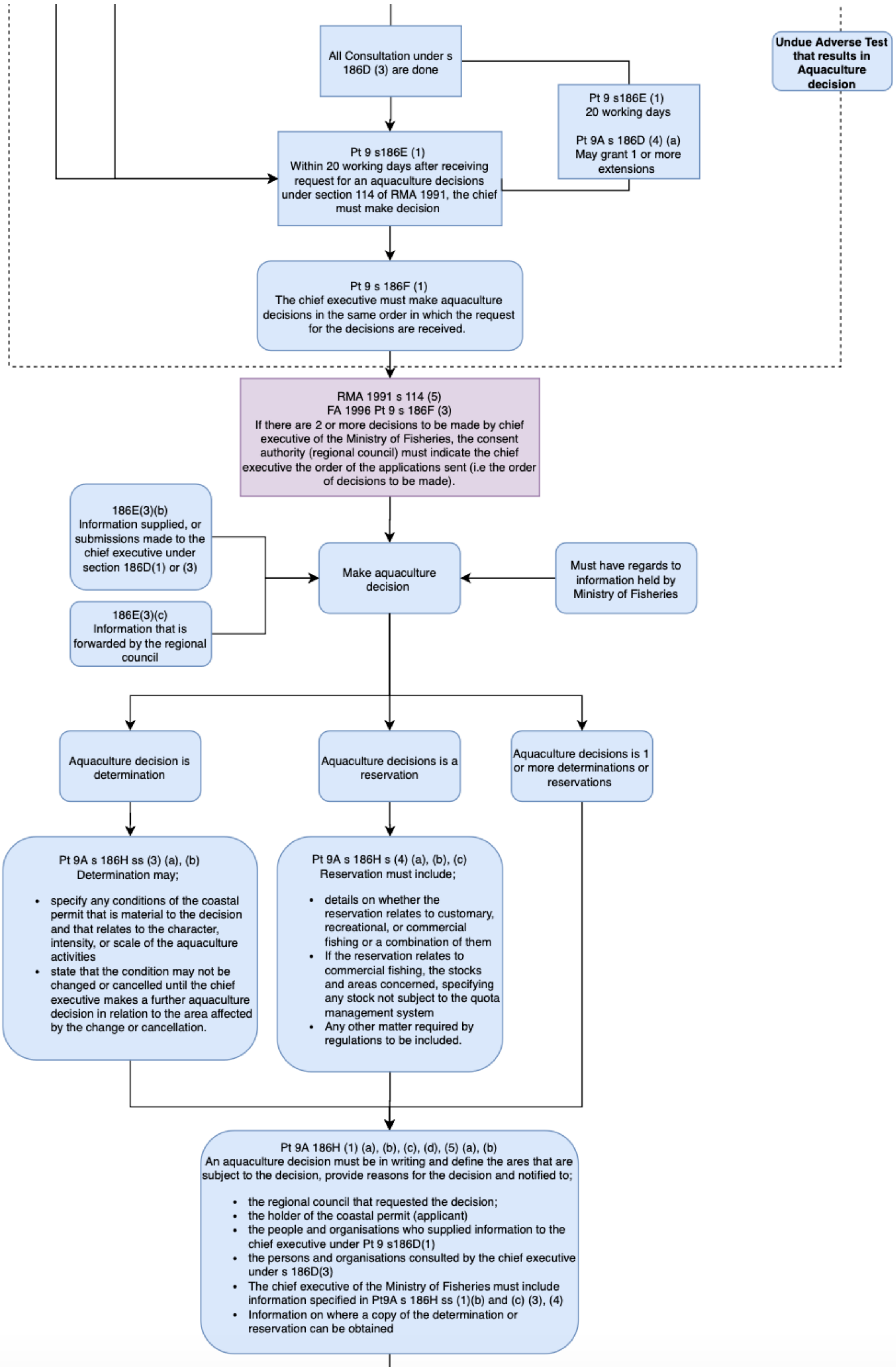
The positive effects of the realignment of the marine farm.
Pt 3 r 14 The existing farm is a restricted discretionary activity
Pt 3 r 21 Is the existing marine farm located within an outstanding area?
No
Yes

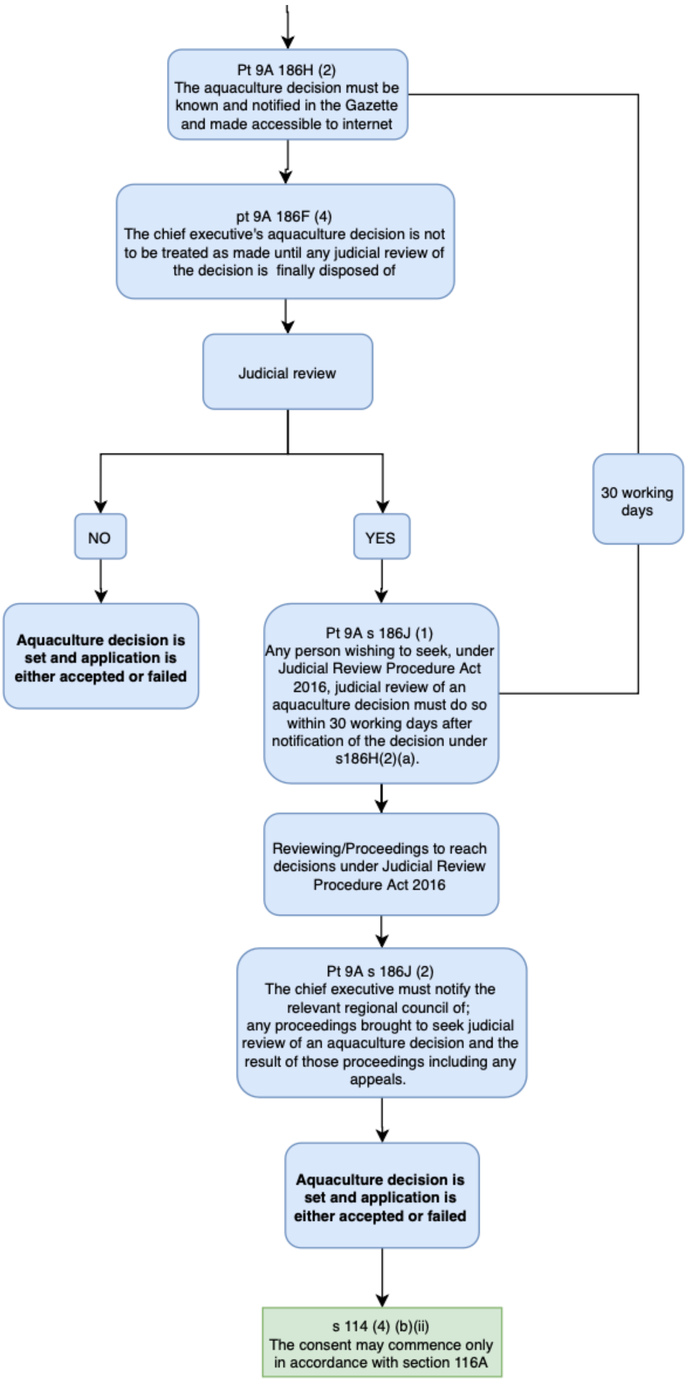

Pt 3 r 18
If the current marine farming is restricted discretionary activity, following matters are restricted for replacement coastal permit
The duration and lapsing of the coastal permit
Review Conditions
When occupation is authorised in relation to seasonal activities such as spat catching
The marine farm structures to ensure continued reasonable public access, navigational safety, colour, visibility and coherent appearance of marine farm structure
The integrity and security of the structure including the anchoring system
The effects of the spat catching activity in the report required by cl 5 of Schedule 6.
The effects of the spat catching on reefs, biogenic habitat and regionally significant benthic species within the area of interest.
Management practices to minimise adverse interactions between marine mammals or seabirds and the marine farm, including entanglements, injury and mortality
The management of biosecurity risks
The management of the effects on the environment of noise, rubbish and debris
If a plan or proposed plan includes an adaptive management approach, outline condition to give effects to that approach.
Information, monitoring, and reporting requirement
Pt 3 r 21
Effects of the activity on the values and characteristics that make the area, feature or landscape outstanding.
Has the application undertaken the process outlined in Schedule 6 within 12 months?
OR
Application include the report required by Schedule 6 cl 5
NO
Yes
r 24 (1)
The applications must not be publicly notified or given limited notification, unless public or limited notification is required under the RMA
r 24 (2)
Application must not be public notified but can have limited notification
If Successful, replacement coastal permit is granted
Application for New Coastal permit (NOT replacement)
s 89A (1)(a)(ii)
Application to build Spat catching structure (Navigational matters)
s 107F
Application to undertake aquaculture activities
s 89A (2)
The local Authority must send a copy of the application to Maritime New Zealand (MNZ)
s 107F
Does this any of these factors apply?
s 89A (4)
MNZ must report to local authority within 15 working days .
RMA 1991 s 107F (a) (ii)
FA 1996 Pt 9A s 186GA (a)(ii)
Has the area been authorised continuously with lease, licence, marine farming permit or spat catching permit that was under other Act or permit granted under RMA
An area that is subject toa coastal permit to which section 114(6) of the RMA 1991 Applies
s 89A (3)
MNZ must report to the local authority on navigational matters including conditions that should added for navigational purposes.
RMA 1991 s 107F (a)(i)
FA 1996 Pt 9A s 186GA (a)(i)
Is the area is or subject to a lease, licence, marine farming permit or spat catching permit that was deemed under s 10, 20, 21 of the Aquaculture Reform Act 2004 to be a coastal permit granted under this Act?
Pt 9A s186GA
The chief must not make an aquaculture decision related to certain area
s 89A (5)
Local Authorities must send copies to the applicant and every person who has made a submission on the application
RMA 1991 s 107F (b)
FA 1996 Pt 9A s 186GA (b)
Is the area subject to the coastal permit to the coastal permit referred to in section 20A of the Aquaculture Reform Act 2004 and the activity has been granted under that act or RMA
Coastal permit to build Spat catching structure (navigational matters)
RMA 1991 s 107F (c)
FA 1996 Pt 9A s 186GA (c)
Is the An area gazetted aquaculture within the meaning of section 35 of Aquaculture Reform Act 2004?


NO
YES
s 107F (3) (a) Application is returned to applicant under s88 (3A)
Continue with 107F
95A (3) Public Notification of consent application to determine whether to public notify an applicaiton for a resource consent
Is the application notified?
s 107F (3) (a) Forward a copy of the application to the Chief Executives of the Ministry of Fisheries
s 107F (3)(b) If information or report is obtained under s 41C, 42A, 92 or 149, forward these information and report to Chief Executive of the Ministry of Fisheries
NO
YES
Limited notification process under Pt 6 s 95B
Public notification process
Submission process under Pt 6 s 96.
Skip to; is a hearing held?
Is it concurrent application?
Pt 6 s 97 (1), (2) For public and limited notification, closing date is 20th working day after the notification
Extension of timeframe under s37 (1)(a) possible
YES
NO
s 107F (4) In the case of a concurrent application that is lodged with the EPA, the copy of submission requried to be sent by the EPA to the Chief Executive is a copy of only those submissions that is related to the concurrent application and NOT those that relates to plan change request
Submission received
s 107F (3)(c) Send the submissions to Chief Executive of the Ministry of Fisheries after the closing date for submissions
Is a hearing held?



NO
Yes
Hearing Procedures
Pt 6 s 115 (3)
If the application was notified and a hearing is not held, the notice of the deision must be given within 20 working days after the closing date for submissions on the application
Pt 6 s 115 (2)
Notice of decision must be given within 15 working days after the end of the hearing
s 114 (4) (a)
Send a copy of the decision and any notice served to the chief executive of the Ministry of fisheries
s 114 (4) (b)(ii)
The consent may commence only in accordance with section 116A
Is there appeal relating to the decision or following competition of any such appeal?
No Process for Appeal
YES
NO
s 114 (4) (c) (i)
Send a copy of the final decision to the chief executive of the Ministry of Fisheries
s 114 (4) (c) (ii)
Request an aquaculture decision from the chief executive under the Fisheries Act 1996
186D (1)
Recieve copy of an application for a coastal permit forwarded by regional council to the Chief Executive under 107F of RMA 1991.
1 week or more extensions possible
Pt 9 s 186D (2)
Chief executive set a date which information must be provided for factors affecting aquacultural decision
Pt 9A s 186D (1) (a)
The applicant for or the holder of the coastal permit
Factors affecting aquaculture decision
Pt 9A s 186D (1) (b)
Any fisher whose interests maybe affected
Part 9 s 186D (1) (c)
Persons and organisations that the chief executive who have customary, commercial or recreational fishing interests that maybe affected by granting/changing/cancelling the conditions of coastal permits.
Pt 9 s 186D (3)
Chief executive may consult any person or organisations regarding factors regarding aquaculture decisions


All Consultation under s 186D (3) are done
Undue Adverse Test that results in Aquaculture decision
Pt 9 s186E (1)
20 working days
Pt 9A s 186D (4) (a)
May grant 1 or more extensions
Pt 9 s186E (1)
Within 20 working days after receiving request for an aquaculture decisions under section 114 of RMA 1991, the chief must make decision
Pt 9 s 186F (1)
The chief executive must make aquaculture decisions in the same order in which the request for the decisions are received.
RMA 1991 s 114 (5)
FA 1996 Pt 9 s 186F (3)
If there are 2 or more decisions to be made by chief executive of the Ministry of Fisheries, the consent authority (regional council) must indicate the chief executive the order of the applications sent (i.e the order of decisions to be made).
186E(3)(b)
Information supplied, or submissions made to the chief executive under section 186D(1) or (3)
186E(3)(c)
Information that is forwarded by the regional council
Make aquaculture decision
Must have regards to information held by Ministry of Fisheries
Aquaculture decision is determination
Aquaculture decisions is a reservation
Aquaculture decisions is 1 or more determinations or reservations
Pt 9A s 186H ss (3) (a), (b)
Determination may;
• specify any conditions of the coastal permit that is material to the decision and that relates to the character, intensity, or scale of the aquaculture activities
• state that the condition may not be changed or cancelled until the chief executive makes a further aquaculture decision in relation to the area affected by the change or cancellation.
Pt 9A s 186H s (4) (a), (b), (c)
Reservation must include;
• details on whether the reservation relates to customary, recreational, or commercial fishing or a combination of them
• If the reservation relates to commercial fishing, the stocks and areas concerned, specifying any stock not subject to the quota management system
• Any other matter required by regulations to be included.
Pt 9A 186H (1) (a), (b), (c), (d), (5) (a), (b)
An aquaculture decision must be in writing and define the ares that are subject to the decision, provide reasons for the decision and notified to;
• the regional council that requested the decision;
• the holder of the coastal permit (applicant)
• the people and organisations who supplied information to the chief executive under Pt 9 s186D(1)
• the persons and organisations consulted by the chief executive under s 186D(3)
• The chief executive of the Ministry of Fisheries must include information specified in Pt9A s 186H ss (1)(b) and (c) (3), (4)
• Information on where a copy of the determination or reservation can be obtained


Pt 9A 186H (2)
The aquaculture decision must be known and notified in the Gazette and made accessible to internet
pt 9A 186F (4)
The chief executive's aquaculture decision is not to be treated as made until any judicial review of the decision is finally disposed of
Judicial review
30 working days
NO
YES
Aquaculture decision is set and application is either accepted or failed
Pt 9A s 186J (1)
Any person wishing to seek, under Judicial Review Procedure Act 2016, judicial review of an aquaculture decision must do so within 30 working days after notification of the decision under s186H(2)(a).
Reviewing/Proceedings to reach decisions under Judicial Review Procedure Act 2016
Pt 9A s 186J (2)
The chief executive must notify the relevant regional council of;
any proceedings brought to seek judicial review of an aquaculture decision and the result of those proceedings including any appeals.
Aquaculture decision is set and application is either accepted or failed
s 114 (4) (b)(ii)
The consent may commence only in accordance with section 116A

Appendix E

Replace the content of this page with your own content. The appendix heading uses the ‘App1’ style.

E.1 Acts

Resource Management Act 1991

Fisheries Act 1996

Aquaculture Reform Acts 2011

Resource Management (National Environmental Standard for Marine Aquaculture) Regulations 2020

E.2 Case laws

Clova bay residents ASSN INC v Marlborough District Council [2016] NZHC

R J Davidson Family Trust v Marlborough District Council [2018] NZCA 316

Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council [2018] NZEnvC 046

Friends of Nelson Haven & Tasman Bay Incorporated v Tasman District Council [2018] NZEnvC 130

E.3 Relevant Policy documents

New Zealand Coastal Policy Statement

E.4 Marlborough Sound District Council

Marlborough Regional Policy Statement

Marlborough Sound Resource Management Plan (MSRMP)

Proposed Marlborough Environment Plan

Decision report for Clova Bay farm

s 42A report for Clova Bay farm

Decision reports on Kuku Mara Partnership

E.5 Tasman District Council

Tasman Regional Policy Statement

Tasman Resource Management Plan

s 42A report for Private Plan Change 61

Analysis of consistency with the Tasman Regional Policy Statement by Wainui bay spat catching group for plan change 61

Evidence of Matthew James Rountree. Dated 15th of August 2016.